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Index to Volume XI.

Acetylene Gas as an Explosive ... 531
Acid for Etching High Speed Steel. (H. & W., 57) ... 656
Acid Hardening Bath. "I. W. Antano" ... 655
Acme Taps in Sets ... 268
Adams-Farwell Automobile ... 131
Adams, John D.
- Elliptical Chuck ... 413
- Three-Piece Ellipsograph Again ... 491
- Three-Piece Ellipsograph 151
- Link Motion for Rotating a Shaft 180 Degrees ... 214
- One-Turn Clutch ... 598

Adding Attachment for the Typewriter ... 371
Adjustable Boring Tool. F. A. Hobbs ... 551
Advertising Scheme, An. R. Earl Weinland ... 547
Advice to Apprentices. John Mark May ... 434
Aeroplane and Flying Machine, The ... 88
Air Compressor with Minimum Clearance Space ... 481
Air-lubricated Journal ... 52
Air Pump, Westinghouse Compound ... 640
Albespeyre Tunnel, The Ventilator of the. Dr. Alfred Gradenwitz ... 32
Alcohol as a Source of Power 641
Alcohol Motor in France, The 318
Allen, Leicester.
- Some Faults of Indexing ... 353

Allis-Chalmers Shops, Spherical Boring and Turning in the ... 574
Alloy of Aluminum, Copper, and Manganese ... 577
Aluminum for Bedplates and Other Castings ... 222
Aluminum, Fusing and Molding of ... 107
Aluminum Patterns, Soldering ... 627
Alternators of the N. Y. Subway, Engine-driven ... 533
Aluminum, Making Castings in ... 35
Aluminum, Soldering. R. Earl Weinland ... 494
Aluminum, Something about. Earl N. Percy ... 413
Amalgam for Stopping Leaks, Blowholes, etc. O. M. Becker ... 655
American Blower Co.'s New Engine, The ... 309
American Industries, German View of ... 370
American Machine Exports to Germany ... 403
Ammonal ... 20
Ammonia on Iron, Effect of. 390
Angle Bars, Method of Bending ... 34
"Angle of Pressure" of Spur Gears ... 331
Angle of V-Tool to Plane Notches, etc. (H. & W., 52) ... 606
Angles from a Table of Tangents, To lay out ... 220
Anisometric Projection. Robt. Grimshaw ... 492
"Antano, I. W."
- To Bronze Yellow Brass ... 605
- Acid Hardening Bath ... 655

Anvil Block, Improved. J. H. DeGroodt ... 379
Application of Motors to Machine Tools ... 372
Apprentice, A Successful ... 99
Apprentices, Advice to. John Mark May ... 434
Apprenticeship Question, The. Prof. John E. Sweet ... 52
Armature, Rewinding of ... 486
Armstrong Bros.' Shops, Making Inserted Cutters in 631
Arras, C. C.
- Prick Punch with Interchangeable Scriber Points 604

Arthur, James.
- A Five Minute Repeater Clock ... 339
- Friction of Sliding Keyways ... 218
- "Standard" Nose Threads for Lathe Spindles ... 95

Artisans—5th Annual Session, Summer School for .. 475
Asbestos, Applying. James A. Pratt ... 604
Ash, Harry.
- Coloring Steel ... 391
- To Mottle Casehardened Pieces ... 331

Ashley, Carroll.
- An Experiment with Gas. 381
- A Leather Medal ... 150

A. S. M. E. Annual Meeting of the ... 236
A. S. M. E., June Meeting of the ... 545
A. S. M. E., Scranton Meeting of the ... 593
Automatic Gear Cutting Machine, An ... 578
Automatic Prick Punch with Adjustment. Otis D. Storer 381
Automatic Twist Drill Grinding Machine ... 511
Auto-meter for Automobiles. 139
Auto-meter, The Warner ... 362
Automobile Record, A High-speed ... 311
Automobiles, Auto-meter for 139
Automobiles, Experiments with ... 258
Automobile Show, The ... 320
"Autopyrophon," The ... 203

Babbitt Crossheads, To. J. V. N. Cheney ... 442
Babbitt Metal or Lead from Exploding, To Prevent. R. B. Casey ... 605
Bachmann, H. J.:
- Wire Straightener ... 151
- Cement for Sticking Leather Fillet on Brass Patterns ... 331
- A System of Drill Jigs for Rough Castings ... 209
- Regarding Accuracy of Jigs ... 330
- Punch and Die Adjustable to Cut Sectors of Various Lengths ... 387
- Milling and Drilling Jig .. 595

Balancing Arrangement for the Rams of Boring Mills ... 202
Balancing Balls, Alleged Method for ... 445
Balancing Centrifugal Pumps 586
Balancing High-Speed Gasoline Engine ... 498
Balancing High-Speed Machinery, Notes upon ... 183
Balancing Moving Parts ... 524
Ball and Roller Bearings, Carrying Capacity of. (How and Why 11) ... 107
Ball-bearing Rifle Gun ... 32
Ball Bearings ... 329
Ball Cases on Internal Bearings, Method for Burnishing ... 384
Ball, M. H.:
- Prick Punch Holder ... 160
- A Finishing Boring Bar for Bronze ... 654

Ball Reamer, Simple ... 104
Band Brake Design, More Notes on. C. F. Blake ... 344
Bandsaw in the Machine Shop, The ... 85
Bandsaws, Cold-soldering .. 202
Bardons & Oliver Lathe, A Large ... 13
Bar Holder, Facing. B. M. Weller ... 269
Barnard, Wm. N.:
- Strength of Beams with Ribbed Sections, a Paradox ... 176

Barney:
- Catching Threads and Gaging the Depth ... 152

Barnitt, Correction in Name 475
Bath Universal Grinding Machine, New ... 360
Baxter, Jr., William:
- Variable Speed Motors ... 26 120, 171, 246, 348, 399, 513

Beale, Oscar J.:
- To Copper Brass for Laying Out Work ... 605

"Beams and Planes Eccentrically Loaded." E. E. Graham ... 175
Beams and Planes with Several Supports. E. E. Graham ... 29
- John S. Myers ... 30
- "C. F. Blake" ... 68

Beams, Graphical Solution for ... 214
Beams with Ribbed Sections, Strength of — A Paradox. Wm. N. Barnard ... 176
Becker, O. M.:
- To Mend Broken Oil Stones 442
- Amalgam for Stopping Leaks, Blowholes, etc. . 655

Bedplates and Other Castings, Aluminum for ... 222
Bell, A. R.:
- Iron and Its Early Manufacture in England ... 185

Bells, Old Formula for ... 421
Bells, The Designing and Making of. F. P. Lotz ... 295
Belt, Improved Method of Allowing for a Slack ... 371
Belting ... 537
Belts, Lacing ... 276
Bench Vise, Quick-action ... 83
Bending Angle Bars, Method of ... 34
Bending Angles and Structural Shapes. Frank B. Kleinhans ... 306
Bending Cast Iron Pipe ... 94
Bending Dies, Some Hints on 273
Bending Fixtures for Two Operations, Set of ... 325
Bending Stresses in Wire Ropes ... 426
Benjamin, C. H.:
- The Bursting Strength of Wooden Pulleys ... 613

Bevel Curve, Solution of the. Charles Clonkey ... 93
Bicycle Ball Stopped a Train, How a ... 582
Bierbach, A. F.:
- Lubricating Soap for Wire Drawing, Screw Cutting and Working Metals ... 444

Bierbaum, C. H.:
- Oil Grooves and the Fitting up of Bearings ... 459

Binder Pulleys versus a Keeper Belt ... 390
Birnstock, W. W.:
- Filler for Defective Castings ... 331

Birrell, Edwin M.:
- Pattern Shop of the U. S. Naval Gun Factory ... 241

Blacken Brass for Templet Work and Other Purposes, To. P. H. Oto ... 495
Blacken Brasswork for Instruments, To. Jos. M. Stabel ... 655
Blacking Brass. F. H. Jackson ... 444
Black Marks on Graduated Surfaces, To Make. F. H. Jackson ... 655
Black Powder, Report on by Chief Mason of Bureau of Ordnance ... 472
Blackwell's Island Bridge, N. Y., Pins Used in the New ... 530
Blake, C. F.:
- More Notes on Band Brake Design ... 344
- Beams and Planes with Several Supports ... 68

Blake (W. H.) Condenser, The ... 500b
Blanking and Forming Dies. V. H. Marcellus ... 649
Bliss Press with Special Feed 644
Bluing from Tempered Steel, To Remove. F. H. Jackson 605
Bluing Small Brass and Steel Articles by Immersion, For. L. E. Muncy ... 605
Blue-prints ... 54
Bluff that Went," "A. "A. P. Press" ... 601
Bog Fuel, The Possibilities of 256
Boiler Explosion ... 657
Boiler, Large Water Space Watertube ... 263
Boiler Plate Ever Rolled, Largest ... 257
Boiler Shell Chart ... 68
Boiler Tube, A Spirally Corrugated ... 86
Borax, Process for Pulverizing. Albert D. Knavel ... 444
Boring and Turning a Cast Iron Bushing in Halves, Method of ... 275
Boring Bar for Chasing Threads ... 153
Boring Bar Holder ... 159
Boring Bar, Radial Attachment for. D. Lindsay ... 330
Boring Brasses, Fixture for. Philadelphia ... 159
Boring, Facing and Turning Small Spur Gears, Appliances for. "Jaymac" ... 650
Boring Mill, A Ridgway 10-16 Foot, The First Tool Produced ... 407
Boring Rotary Pump Casing, Tool for. L. Myers ... 440
Boring Taper Holes in Lathe Tail Spindles. E. H. Fish .. 651
Boring Tool, Adjustable. F. A. Hobbs ... 551
Bornholt, O. C.:
- Bushings for Drilling and Reaming Jigs ... 491

"Boston Tool" for Model Work ... 277
Bouvier Governor for Water Turbines. Dr. Alfred Gradenwitz ... 523
Boy Electricians ... 267
Brains are His Own, A Man's 422
Brass Railings, Cost of Polishing ... 297
Brass, Silver Paste for. J. S. Gordon ... 391
Brass Wire in Brazing, The Use of. F. H. Jackson .. 605
Brasswork for Instruments, To Blacken. J. M. Stabel 655
Brass Work, Frosting. F. H. Jackson ... 495
Bridge Building since 1880 .. 86
Bridge Over St. Lawrence River, Steel ... 585
Bridge, The Zambesi River .. 144
Bristol:
- Loose Pulleys ... 490

Bristol, F. B. (Obituary) ... 184
British Industrial Methods, Reorganization of ... 294
British Patent Laws, Stricter 140
Bronze, A Finishing Boring Bar for. M. H. Ball ... 654
Bronzes, Characteristics of .. 312
Bronze Yellow Brass, To. I. W. Antano ... 605
Brooks, Wm. H.:
- A Handy Tool for Locating and Aligning Shafting and Machinery ... 76

Bruised Threads, To Straighten ... 389
Brooks, W. J.:
- Flexible Curves for Draftsmen ... 497

Brutsche, A. J.:
- Method of Boring and Turning Cast Iron Bushing in Halves ... 275

Buchet, E. J.:
- How the Pillow-block Seat of a Large Engine was Planed Out with a Small Planer ... 218
- Modern Work with Ancient Tools ... 649

Buffing Wheels, Exhausting Arrangement for ... 475
Building Construction, Steel Cage ... 640
Bullard 36-inch Vertical Turret Lathe ... 367
Bullard Machine Co., Method of Finishing Gears at ... 16
Burbank, L. S.:
- Table of Spur Gear Teeth Giving Diametral Pitch 212
- Mixture for Making a Porous Casting Air and Water Tight ... 444

Burnishing Ball Cases on Internal Bearings, Method for 384
Burns, Charles E.:
- Improvised Vertical Milling Machine ... 323

Bursting of Four-foot Flywheels, The ... 261
Bursting Strength of Wooden Pulleys, The. C. H. Benjamin ... 613
Bushings for Drilling and Reaming Jigs. O. C. Bornholt ... 491

Calculating Charts ... 425
Calipering the Fit of a Screw Thread. H. E. Wood ... 275
Camera, A Sketching. Warren E. Willis ... 326
Camming Screw Machines for Thread Cutting. G. H. 388
Cam, The Davis Self-Locking 44
Carborundum Wheels. Ezra F. Landis ... 102
Car Inspectors are Beaten, How ... 40
Carnegie Engineering Building, Plans for the ... 137
Carpet Tack, New ... 33
Carriage Stop for Lathe. J. A. Webster ... 383
Carrying Capacity of Ball and Roller Bearings (How and Why 11) ... 107
Calcium Reduced by Electrolysis ... 533
Car Wheel Press, Handy Water Connection for. A. E. Mitchell ... 443
Car Wheels, Rolled Steel ... 427
Casehardening ... 642
Case-hardening Cast Iron. A. 605
Casehardening Preparation, Formula for. James P. Hayes ... 391
Casey, R. B.:
- Mixture for Plugging Holes in Cast Iron ... 495
- To Recut Old Files ... 391
- How a Triple Worm was Cut ... 220
- To Prevent Babbitt Metal or Lead from Exploding 605

Cast Iron Bushing in Halves, Method of Boring and Turning. A. J. Brutsche .. 275
Castings in Aluminum, Making ... 35
Cast Iron Sinks ... 158
Cast-Iron Spring Piston Ring, Proportions for a (H. & W. 38) ... 445
Cast Iron, to Harden—To Keep Water from Freezing or Souring. W. T. Sears. 444
Catching Threads and Gaging the Depth. Barney ... 152
Catgut ... 638
Cement for Holes and Cracks in Castings. C. E. Mink .. 605
Cement for Metals. H. S. Gladfelter ... 655
Cement for Iron. David Melville ... 605
Cement for Slicking Leather Fillet on Brass Patterns. H. J. Bachmann ... 331
Cement for Steam Pipes, Permanent Iron. J. H. Taylor 495
Cement, Novel Use of ... 648
"Center-Pressure" Stop Valve 434
Centrifugal Pumps, Balancing 586

Centrifugal Pumps for Elevator Service, Multi-Stage 583
Chain Drive in a Rubber Mill 136
Chain, Manufacture of 318
Change Gear Device, Proposed. E. H. Fish 48
Change Gears for Diametral Pitch Worm Teeth. John T. Giddings 153
Changes of Lead Due to Hardening, Lathe Gearing Compensation for. Hans Dahlstrand 436
Chart for Hollow and Solid Shafts 148
Charts, Calculating 425
Charts for Forming Tools, Geo. D. Hayden 103
"Charts for Forming Tools," Error in 130
Charts in Designing. John S. Myers:
(1) 9
(2) Thickness of Cylinders 90
(3) Helical Springs 145
Chasing Threads, Boring Bar for. D. Lindsay 153
Checking a Drawing. Julian F. Page 382
Cheney, J. V. N.:
To Babbitt Crossheads 442
To Heat the Tips of Small Tools 391
Chern, A. R.:
Device for Preventing wear of Shaper Tools 98
Chimney, A 182-foot Concrete 311
Chimney, How to Fall Down a 389
Chimneys Built from a Derrick 139
Chuck, An Expansion. J. M. Stabel 549
Chuck, Elliptical. John D. Adams 413
Chuck for Holding End Mills. L. E. Muncy 105
Chucking Fixture. P. A. R. 654
Chuck Jaws, To True Universal. J. E. Manlerre 214
Chuck Plates, Patterns for. E. H. Fish 51
Chucks, Time-saving, A. Mertes 95
Circuit Breaker with Solenoid Attachment. Herbert S. Gladfelter 597
Civilized, Though Savage 389
Clamp Coupling in Cement Mills, The Advantage of the. H. A. Houghton 214
Cleaning Tenders, Sand Blast Apparatus for 89
Cleaning, Vacuum System of 53
Clock, A Five-Minute Repeater. James Arthur 339
Clock, Handless 33
Clonkey, Charles:
Solution of the Bevel Curve 93
Clutching and Speed Accelerating Device of the Cutler-Hammer Mfg. Co., Novel, Magnetic 468
Clutch, One-Turn. J. D. Adams 598
Clutch Shifter, Magnetic. Herbert S. Gladfelter 271
Clutch Teeth, Milling Square Jaw. Draftsman 221
Coal, Relative Economy in Different Sizes of 402
Coal, Statistics of the World's Output of 167
Coat Zinc Sheet Black for Templet Work, To. Alex. C. Labar 331
Cocoa, Wonderful Power of. 615
Coffee Mill, Construction of an Old. H. Jonson 653
Coil-clutch Reversing Gear 423
Coiled Spring Mounted on a Mandrel, Advantages of 423
Cold-soldering Bandsaws 202
Cold Tinning Process for Use on Finished Work in Iron, Brass or Steel. J. L. Lucas 655
College Engineering Courses, Increase of Students Taking 423
Coloring Steel. Harry Ash. 391
Colors, The Use of Distinctive. Oscar E. Perrigo 364
Columns, The Strength of 428
Colvin, Fred H.:
The Practical Perspective 45
Combination Forming Die. W. Van Orman 438
Commutators in which the Mica Insulation has Burned Away, Repairing 645
Comparisons and Notes on Prime Movers 313
Compressed Air as an Aid to Fan Blast in Forge Shop. A. E. Mitchell 437
Compressed Air, Water Pressure Maintained by 171
Compression Space in a Gas Engine Cylinder (How and Why 14) 161
Concrete Construction, Great Strength of 140
Concrete for Setting Posts, Advantages of Using 201
Concrete Piles, Run Forced, 368
Concrete, Proportions and Character of Sand and Gravel to Use in 530
Concrete, Reinforced 588
Condensation Fallacies and Facts 38
Condensers for Steam Turbines 260
Connecticut Still Safe, The 138
Connecting Shafts (How and Why 8) 107
Construction, Steel-concrete. 86
Consumption of Steel Increased 477
Contest Between Guns and Armor 638
Cooking Stoves, Fireless 637
Coolgardie Pipe Line, Construction of the 403
Copper Alloyed with Iron 67
Copper Brass for Laying Out Work, To. O. J. Beale 605
"Copper Floats" 251
Copper on Old Whalers 33
Copper Solution that Will Color on Oily Steel 655
Copper-Vanadium 568
Copper Wire, Hard-drawn 430
Copying Printed Pictures, A Process for. Joseph C. Riley 5
"Core and Coil" Problem, The 545
Core Box from the Pattern, Making a. Julian D. Page 158
Correction, A Table of Spur Gear Teeth Giving Diametral Pitch 383
Correction in August Data Sheet 33
Correction in Name, Barnitt. 475
Correction of a Calculation in "Eccentric Loading." F. B. Kleinhans 354
Correction of February Data Sheet 389
Corrugated Grinding Wheel, The 500a
"Corubin," Resistance of 122
Cost, How Much Does It 584
Cost of Cutting by Emery Wheels and by Filing, Relative 141
Cost of Increased Rapid Transit Facilities in New York 139
Cost of High Speed Steel 230
Cost of Polishing Brass Railings 297
Cost of Power in Street Railway Service 317
Counterbalancing an Oscillating Engine 632
Counterbore, Special. W. C. Force 652
Covering Pulleys with Leather. C. E. Mink 596
Cracks in Castings, To Repair 311
Crane Co., Fiftieth Anniversary of 620
Crane Motors, Calculations for the Shaft, Gear and Bearings of. G. J. Leire. 565
Crane Motor Testing Apparatus 541
Crematory in New York City with Electric Lighting Plant, Experiment for 423
Criticism, A. E. Kwartz 602
Criticism, A friendly 532
Crown Brasses, Tool for Laying out. R. G. D. 249
Crossheads, To Babbitt. J. V. N. Cheney 442
Crown Gear Defined (How and Why, 35) 390
Crucible Steel for Turning and Planing Tools, etc. J. M. Gledhill, of Armstrong, Whitworth & Co. 423
Crude Oil to Generate Electricity 398
Crushed Coal for Locomotives 86
Cunard Turbine Steamers 70
Cunard Vessel, New 139
Custodis Brick Chimney, A 130
Cutter Construction, Inserted Blade. H. D. 549
Cutting and Applying Gaskets. J. A. Pratt 494
Cutting, Drawing and Knurling Die, A Combined. C. F. Emerson 275
Cutting English Threads with Metric Leadscrew A. L. Valentine 440
Cutting Multiple Threaded Screws John T. Giddings. 153
Cutting Multiple Threads with a Chaser. T. E. Remington 330
Cutting off Stock in Engine Lathes. Herman Jonson 221
Cutting Threads on a Metric Lathe, English System 330
Cutting Tools and Application to Lathe Design, Experiments with 481
Cutting Tabs on Index Cards (How and Why, 60) 657
Cylinder Grinder, Heald 644

Dahlstrand, Hans.
Lathe Gearing Compensation for Changes of Lead due to Hardening 436
Dall, C. M.
Self-aligning Holder for Screw Machine 388
Damascus Steel a Form of High Speed Steel 257
Danger of Oil in Boiler Furnaces 533
Dangerous State of Streets in our Large Cities 639
Data Sheet, Correction in August 33
Data Sheet Errata, January. 318
Data Sheet for November 119
Data Sheet for September, The 25
Davis, Frank M.
Repairing a 400-Ton Hydraulic Press 630
Davis Self Locking Cam, The. 44
Death of Mr. George A. Gray. 567
Deep Mine Hoisting Engines. 204
Defective Castings, Filler for. W. W. Birnstock 331
Definitions of Early Writers. 573
De Forest Wireless Ship Localizer 290
"Defries" Precision Lathe, The. Dr. Alfred Gradenwitz 147
De Glehn Locomotive, Heating Surface of a 85
De Groodt, J. H.
Improved Anvil Block 379
De Laval Steam Turbine and Its Manufacture 123
De Laval Steam Turbine Co., The 61
De Leeuw, A. L.
High Speed Planers 501
Generating a Large Index Plate 624
Simple Solution of Question No. 55 656
Derf, R. E.
Simple Gear Cutting Device 388
Designing and Making of Bells, The. F. P. Lotz 295
Designing, Charts in. John S. Myers:
(1) 9
(2) Thickness of Cylinders 90
(3) Helical Springs 145
Diametral Pitch, Worm Teeth, Change Gears for. J. T. Giddings 153
Diamond Drill Borings in the Transvaal 533
Diamonds Used for Dies for Drawing Wires of the Smaller Sizes 585
Diamond Tools 260
Die, Combination Forming. W. Van Orman 438
Die, A Combined Cutting, Drawing and Knurling. C. F. Emerson 275
Dies, Blanking and Forming. V. H. Marcellus 649
Dies for Making Tin Nozzles, Practical 487
Dies, Making Drop Forging. C. W. Shelly 266
Dies, Some Hints on Bending 273
Differential Gearing, Some Cases of. A. B. 74
Differential Indexing, Formulas for. J. O. Villars. 154
Dimensions of Ells and Tees for Wrought Iron Pipe. W. J. Mann 529
Diploma, A Jap 136
Dirt from Clean (?) Floors. 201
Disch, Theodore.
Insulating Covering for Steam Pipes and Boilers. 444
Pulley Crowning Device 491
Distance between two Ell's Connecting two Parallel Lines of Pipe, Method of Finding 319
Distinctive Colors, The Use of. Oscar E. Perrigo 364
Distortion of Automobile Wheels in Photographs 25
Double Head Tool for Plate Planers. Toolmaker 443
Draft Fan, Large Mechanical 133
Draft Gage, Improved 55
Drafting Kink. A. E. H. Fish 104
Drafting Room Practice Ralph E. Flanders. 355
Draftsman.
Milling Square Jaw Clutch Teeth 221
Lathe Rig for Turning Machine Handles 217
Draftsmen's Competition, A Novel 340
Draftsmen's Number of Machinery (September) 532
Drawing Board, Parallel Motion for H. M. B. 215
Drawing D. C. Coils, Directions for. Oscar Stegeman 174
Drawings, Labor saving scheme for Making C. W. Putnam 49
Drawing Table, Improvised Geo. Washington 137
Drawing Table and Book stand for Traveling Mechanics J. H. A. 324
Drill Breakage, To Reduce Small. Park B. Shee 494
Drilling and Reaming Jigs, Bushings for. O. C. Bornholt 491
Drilling Hard Steel, Solution for. C. E. Mink 495
Drilling Holes, Practice in (How and Why, 45) 498
Drill Jigs for Rough Castings, A System of. H. J. Bachmann 209
Drill Jigs, Method for Making N. J. W. 383
Drill Press Attachment, A Novel. J. V. Woodworth 490
Drills, Experiments with High Speed Steel. 259
Drill Speeds Table 148
Driving Boxes, Device for Lifting I. C. Hicks 105
Drop Forging Dies for Copper Shrinkage Allowance in (How and Why, 43) 498
Drop Forging Dies, Making C. W. Shelly 266
Drop Hammers for Pile Drivers, Superiority of 139
Dry Air System, Gayley 534
Durfee, Frederic E.
Rules for Figuring the Speed of Pulleys and Gears 597
Dust laid by Oil or Calcium Chloride 86
Dynamo, A Commercial Unipolar 375

East Boston Tunnel, New 369
Eccentric Loading. Frank B. Kleinhans 30
"Eccentric Loading," Correction of a Calculation in. F. B. Kleinhans 354
Economizer, Sturtevant 106
Economy in Different Sizes of Coal, Relative 402
Eckelt, Otto:
To Measure the Radii of Deep-hole Drills 298
Education, Contemporary Technical 245
Effect of Oil on Portland Cement 545
Effect of Traction Wheels of Electric Motor Cars 604
Efficiencies of Various Kinds of Gears 565
Electrically Driven Sand Mixer 500a
Electrical Repair Job, An. "Jaymac" 652
Electric Cables, New Method of Laying 311
Electricity for Heavy Railway Operations, Use of 533
Electricity Produced from Burning Refuse 423
Electric Locomotive, Trial 176
Electric Motor Drive in the Naval Gun Factory 351
Electric Motors in Steel Mills 544
Electric Motor Versus the Steam Engine, The 312
Electric Motors 638
Electric Plants for London and Suburbs 643
Electric Power First Generated at Niagara 309
Electric Repairing. Norman G. Meade:
(1) The Commutator 187
(2) Armature Winding 249
(3) Armature Coils 307
Electric Sign, The Largest 311
Electric Welding 585
Elementary Principles, Importance of 256
Elliott, H. D.:
Feed Relief for Planer Under Cutting Tool 654
Ellipses, Lathe for Turning 372
Ellipsograph Again, Three Piece. John D. Adams 491
Ellipsograph, Three-Piece. J. D. Adams 151
Ellipsograph, Three-piece A Criticism. Charles G. Taylor 386
Elliptical Chuck John D. Adams 413
Elliptic Curves, Simple Device for Drawing 496
Emergency Repair Jobs 636
Emerson, C. F.:
A Combined Cutting, Drawing and Knurling Die 275
Planer Bar with Stiff Support 96
Making Redrawing Dies Economically 436
Don't Use Lard Oil on Machinery 653
Emerson, F.:
Mortar for Stopping Holes in Boiler Settings, etc. 655
Emery for Fine Lapping, To Prepare, J. M. Stabel 494
Emery Wheels, Experimental Work on Solid 204
Emery Wheels to Rupture, The Resistance of 35
Employees, Subway 53
Employees at Panama, Regulations for 422
Energy Expended in the Production of Light 637
Engine Beds, Planing. F. H. J. 442
Engine-driven Alternators of the N. Y. Subway 533
Engineer as a Business Man, The 34
Engineering Courses, Increase in Prof. W. G. Raymond 423
Engineering Standards, Working Toward 137
Engines for U. S. Armored Cruisers Nos. 6 and 9, the California and South Dakota. Earl N. Percy 198
Engines at Nashville Tenn., Old 477
Engines, Old Pair in Use Since 1844 477
Engine, The American Blower Co.'s New 309
English High Speed Planer, An 576
English Lathes, Some James Vose 21
English Threads, Cutting with Metric Leadscrew A. L. Valentine 439
Epicyclic Gearing, Solution of Problem in (How and Why, 39) 445
Epochs in Marine Engineering 378

Erratum ... 545
Error Corrected: Steel Hardening and Tempering Compound. W. S. Hindman, Columbus, Ga. 528
Error Corrected in Table of Spur Gear Teeth Giving Diametral Pitch ... 276
Error in Charts for Forming Tools ... 130
Essen and the Krupp Works 6
Estimating Cost, with Examples Illustrating Application of Method. James A. Pratt ... 71
Estimating the Cost of Machine Work. J. A. Webster ... 569
Etching Fluid. T. Melville . 605
Etching Solution. L. Meyers 444
Ethics of Contributions.... 584
Evaporation, Multiple-Effect. 427
Exhausting Arrangement for Buffing Wheels ... 475
Expanding Nozzle in De Laval Steam Turbine ... 54
Expansion Chuck, An. J. M. Stabel ... 549
Expansion Chuck for the Vertical Mill, An. Uncle Josh ... 380
Expansion of Cast and Tool Steel Respectively (How and Why 37) ... 445
Experimental Gas Turbine, An. Dr. Alfred Gradenwitz ... 169
Experiments with Non-magnetic Metals to Form Alloys ... 423
Explosion, Boiler ... 657
Explosions of Gasoline and Other Inflammable Liquids, Device for Preventing... 87
Explosive, Acetylene Gas as an ... 531
Eye Inflamed by Emery Wheel Sparks, To Avoid and Cure (How and Why 30) ... 231
Eye Surgery, Simple ... 119

Facing Bar Holder. B. M. Weller ... 269
Facing Segment Gears ... 221
Facing Valve Seats Without Removing the Pistons ... 370
Fairfield, Howard P. Shop Training for Mechanical Engineering ... 517
Failure of Iron Plate from Fatigue ... 638
Falk, E. C.:
Methods for Obtaining the Distance Between Ells to Connect Parallel Lines of Pipe ... 528
Fall Down a Chimney, How to ... 389
Fan and Special Form of Heater, furnished by B. F. Sturtevant Co. ... 497
Fan Blast in Forge Shop, Compressed Air as an Aid to. A. E. Mitchell ... 437
Fans vs. Positive Pressure Blowers ... 258
Faults of Indexing, Some. Leicester Allen ... 353
Fay, W. L.:
Planing Spiral Corrugated Rolls ... 274
Milling Cutters with Teeth Cast in ... 653
Feed Gear, Screw Cutting with the ... 104
Feed Relief for Planer Under Cutting Tool. H. D. Elliott ... 654
Fiberloid ... 55
Field Coils, Repairing. N. G. Meade ... 529
Figuring the Speeds of Pulleys and Gears, Rules for. F. E. Durfee ... 597
File a Sharp Scriber, To. R. A. Lachmann ... 597
Files by American Methods, The Making of Fine Toolmakers' ... 431
Filler for Defective Castings. W. W. Birnstock ... 331
Finishing Boring Bar for Bronze. A. M. H. Ball. 654
Finishing Gears at the Bullard Machine Tool Co., Method of ... 16
Fire Cement, Mixture for. C. E. Mink ... 605
Fire Engines in Vienna, Motor-driven ... 533
Fire Engines, Early ... 257
Fireless Cooking Stoves... 637
Fire Protection in Marshall Field Department Store, Chicago ... 245
Fireproof Wood in Buildings 14
Fire, The Greenwood Colliery ... 70
Fish, E. H.:
Proposed Change Gear Device ... 48
Patterns for Chuck Plates 51
A Drafting Kink ... 104
Quick-return Shaper Motion ... 97
Some Simple Red Tape... 628
Boring Taper Holes in Lathe Tail Spindles... 651
Fishing Boats, Motors on... 84
Five Levels of Transportation in New York, Proposed ... 88
Fixture, A Sectional. Ralph E. Flanders ... 93
Fixture for Boring Brasses, Philadelphia ... 159
Flanders, Ralph E.:
A Sectional Fixture ... 93
On the Shape of Rolls for Cylinder Cams ... 209
Drafting Room Practice... 355
An Ingenious Mechanical Movement ... 489
Flexible Curves for Draftsmen. W. J. Brooks... 497
Flexible Staybolt Problem... 583
Flying Machine, The Aeroplane and ... 88
Flywheels on Board Ship, Gyroscopic Effect of ... 477
Flywheels, The Bursting of Four-foot ... 261
Fog-makers, Locomotives as 602
"Fool proof" Engine, A... 77
Forced Draft Instead of Induced Draft, Use of... 533
Forced Grease Lubrication System ... 482
Forced Lubrication, Increase of Efficiency by ... 193
Force, W. C.:
Special Counterbore ... 652
Foreman:
"The Man Who is the Whole Thing" ... 321
Forging and Tempering Tool Steel. R. H. Henderson ... 67
Formed Cutters on the Lathe, Making. Charles Thiel... 216
Forming Die, Combination. W. Van Orman... 438
Forming Dies, Striking Up. Pedro Re- ... 384
Forming Tools, Charts for. George E. Hayden ... 103
Fortin, B. P.:
Jigs and Milling Fixtures with Operation Sheet... 265
Foundry Micrometer for Test Bars ... 321
Frictional Gearing, Power Transmission by (How and Why 22) ... 222
Friction Disk Drives, Design of (How and Why 58)... 656
"Friction of Sliding Keyways," James Arthur.... 218
Friction of Sliding Keyways 168
Friction Saw, A Large.... 543
Frosting Brass Work. F. H. Jackson ... 495
Furnace, A New Hardening.. 264
Furnace, The Gautt.......500a
Fusing and Molding of Aluminum (How and Why 10) ... 107

Gage Making. F. E. Shailor 546
Galvanizing Iron, New Sherardizing Process for... 637
Galvanizing Process, New... 33
Gang Milling of Repetition Castings. Joseph V. Woodworth ... 582
Gas, An Experiment with. Carroll Ashley ... 381
Gas as a Motive Power and Its Relative Cost ... 641
Gas Engine Design, Frequent Mistake in ... 636
Gas Engine Economy. George Miller ... 305
Gas Engine Power Plant... 106
Gas Engines on Shipboard, Producer ... 373
Gas Engine Testing ... 376
Gas for Intermittent Heating, Value of ... 371
Gaskets, Cutting and Applying. J. A. Pratt ... 491
Gas Turbine Problem, Practical Investigations in... 180
Gasoline Engines for Bicycles 32
Gasoline Motive Power for Suburban Traffic ... 371
Gasoline Motor Railway Cars 534
Gasoline Motors ... 85
Gas Producer Power Plants. 539
Gayley Dry Air System... 534
Gear Cutting Device, Simple. R. E. Derf ... 388
Gear Cutting Machine, An Automatic ... 578
Gearing, Some Cases of Differential. A B... 74
Gears as Used in Rolling Mills, The Forms and Relative Advantages of Teeth in ... 485
Gears, Efficiencies of Various Kinds of ... 565
Gear Wheels by a Rolling Process, To Make... 497
Generating a Large Index Plate. A. L. DeLeeuw ... 621
Generators, Oil-Insulated... 638
German Fear of Publicity.. 586
German Manufacturers Demand Higher Tariff on Machine Tools ... 139
German Oil Filter ... 648
German View of American Industries ... 370
German Workmen to Sports, Indifference of ... 87
Giddings, John T.:
Change Gears for Diametral Pitch Worm Teeth. 153
Cutting Multiple Threaded Screws ... 153
Gladfelter, Herbert S.:
Magnetic Clutch Shifter.. 271
Circuit Breaker with Solenoid Attachment ... 597
Cement for Metals ... 655
Glass or Bright Metal, To Write Black on. F. H. Jackson ... 444
Glue for Leather Belts. L. E. Muncy ... 495
Glue, Formula for Insoluble. 201
Gold from Sea Water... 469
Gold Welding ... 107
Gordon, J. R.:
The Grinding of Thread Gages ... 78
Accurate Jig Making ... 156
Accurate Jig Making... 328
Lathe Attachment for Turning Trolley Wheels 47
Silver Paste for Brass... 391
Gould, Stanley:
Rig for Re-turning Piston Rings ... 488
Gould, W. E.:
Milling Flat Forming Cutters ... 602
Governing Under High Heads, Sensitive ... 86
Gradenwitz, Dr. Alfred:
The Ventilator of the Albespyre Tunnel ... 32
The "Defries" Precision Lathe ... 147
An Experimental Gas Turbine ... 169
A Novel Process for Testing Lubricants... 415
The Bouvier Governor for Water Turbines ... 523
Graduated Surfaces, To Make Black Marks on. F. H. Jackson ... 655
Graduating for Degrees in the Index Head. C. J. Shaw ... 442
Graham, E. E.:
Beams and Planes with Several Supports ... 29
Beams and Planes Eccentrically Loaded ... 175
Grant's Receipt for Whitewash. W. E. G... 391
Gray, Death of Mr. George A. 567
Great Britain, Germany and America, Invention in.... 516
Greenwood Colliery Fire, The 70
Grimshaw, Robert:
German Lathe Carriage for Screw Cutting ... 79
Anisometric Projection ... 492
Micrometer Gage for Milling Cutters ... 443
Triangle for Isometric Drawing ... 386
Heating Baths for Use in Steel Hardening ... 599
Grinding Machine, Automatic Twist Drill ... 511
Grinding Machine, New Bath Universal ... 360
Grinding of Thread Gages, The. J. R. Gordon... 78
Grinding Operation, An Interesting ... 623
Gunpowder to Avert Hailstorms, Using ... 350
Guns and Armor, Contest Between ... 638
Guns, Enormous Pressure of Modern ... 647
Guteruth Valves for High-Speed Pumps, The... 478
Gyroscopic Effect of Flywheels on Board Ship.... 477

Hacksaw as a Parting Tool in the Lathe, Using a. Robert B. Otis ... 222
Hack Saw Kinks. R. A. Lachmann ... 604
Hail Storms, Using Gun Powder to Avert ... 350
Hafner, John C.:
Some English Inserted Cutter Tools ... 385
Halifax Dock Yard in Nova Scotia ... 469
Hamilton - Holzworth Steam Turbine, The ... 134
Hammacher, Schlemmer & Co., New Store of... 368
Hand Taps with Standard Threads. H. D... 603
Haphazard Supplying of Coal to Locomotives ... 86
Hard-drawn Copper Wire... 430
Harden Cast Iron, To. W. T. Sears ... 444
Hardening Bath, Acid. I. W. Antano ... 655
Hardening Circular Forming Tools (How and Why 59) 656
Hardening Furnace, A New. 264
Hardening High-Speed Steel, Paste for. J. M. Stabel.. 495
Hardening of Hack Saw Blades (How and Why 50) 606
"Hardening Work in Part." Another. C. H. A. ... 104
Harden Thin Saws Without Warping, To. V. H. Marcellus ... 494
Hard Rubber, Alleged Discovery of the Process for Making ... 140
Hard Steel, Solution for Drilling. C. E. Mink... 495
Hayden, George D.:
Charts for Forming Tools. 103
Hayes, James P.:
Formula for Case-Hardening Preparation ... 391
Heads of Machine Screws, Notes on ... 589
Head Work Greater than for Hand Work, Demand for.. 476
Heald Cylinder Grinder ... 644
Heating and Ventilating Apparatus for the New Wanamaker Stores ... 236
Heating Baths for Use in Steel Hardening. Robert Grimshaw ... 599
Heating Surface of a De Glehn Locomotive ... 85
Heat Question as Affecting the Accuracy of Machine's Operation, Something on the. McAnic ... 549
Heat the Tips of Small Tools, To. J. V. N. Cheney 391
Heavily Loaded Bearings, High-Pressure Oiling System for ... 236
Heavy Fluids, Pumping ... 406
Helical Gears, Constructing a Train of (How and Why 48) ... 552
Helical Springs, Tests of.... 624
Henderson, R. H.:
Tool Steel Forging and Tempering ... 67
Hicks, I. C.:
Device for Lifting Driving Boxes ... 105
High Carbon Steel ... 638
High-Pressure Oiling System for Heavily Loaded Bearings ... 236
High-Speed Automobile Record, A ... 311
High-Speed Gasoline Engine, Balancing (How and Why 44) ... 498
High-Speed Machinery, Notes Upon Balancing ... 183
High-Speed Planer, An English ... 576
High-Speed Planers. A. L. De Leeuw ... 501
High-Speed Pumps, The Guteruth Valves for ... 478
High-Speed Steel ... 85
High-Speed Steel, Cost of... 230
High-Speed Steel Drills, Experiments with ... 259
High-Speed Steel in the Machine Shop of To-day. J. J. Jenkins ... 46
High-Speed Steel Razors... 256
High-Speed Steel, Tests on.. 475
High-Speed Steel, The Uses of. G. H. B... 420
High-Speed Tools, The Development and Use of ... 194
High Temperature on the Strength of Steel, Effect of 257
Hindman, H. S.:
Steel Hardening and Tempering Compound... 444
Historical Interest, Of... 421
Hobbs, F. A.:
Adjustable Boring Tool... 551
Historic Locomotive, A... 85
Hoisting Engines, Deep Mine 201
Hoisting Machinery, Modern Steam. A. M. Levin.... 453
Hollow and Solid Shafts, Chart for ... 148
Hollow Mill, Adjustable. V. H. Marcellus ... 51
Hollow Mills, Regarding the Teeth of. C. H. Rowe.... 215
Honesty the Best Policy.... 370
Hose Coupling ... 496
Hot Water for the Tin Shop. Park B. Shee... 277
Houghton, H. A.:
The Advantage of the Clamp Coupling in Cement Mills ... 214
Milling a Large Screw.... 384
How Bill Changed His Job. A. P. Press ... 151
How Can Locomotive Boiler Construction be Improved? 430
Hydraulic Pipe Flanges, Standard. F. B. Kleinhans ... 618
Hydraulic Press, Repairing a 400-ton. F. M. Davis... 630
Hydraulic Valve Improvement. W. T. Sears ... 270

Iayonac:
More Shop Cost Troubles.. 414
Idle Machines, Something More Regarding. A. Mertes ... 95
Improved Bumping Posts ... 430
Improvement All Along the Line ... 177
Impulse and Reaction Turbines ... 346
Incandescent Lamp, A New. 423
Indelible Pencil in Photography, The ... 219
Index for Machinery (1903-4) 70
Index Head, Graduating for Degrees in the. C. J. Shaw 442
Indexing, Some Faults of. Leicester Allen ... 353
Index Plate, Generating a Large. A. L. De Leeuw.. 621
Indicator, A Simple. J. Mathieu ... 277
Induction of an Underground Cable as Compared with a Line Wire ... 371
Industrial Methods, Reorganization of British ... 294
Inflamed Eyes, Remedy for (How and Why, Ans. to 30) ... 390
Ingersoll-Sergeant Drill Co., New Works of the ... 461
Injured Steel, Remedy for.. 88
Inserted Blade Cutter Construction. H. D... 549
Inserted Blades, Method of Securing. G. L. F... 425
Inserted Cutters in Armstrong Bros.' Shops, Making ... 631

Inserted Cutter Tools, Some English. John C. Hafner 385
Inspectors are Beaten, How Car ... 10
Insulating Covering for Steam Pipes and Boilers. Theodore Disch ... 441
Intermittent Heating, Value of Gas for ... 371
Internal Combustion Engines and the Diesel Principle .. 39
International Railway Congress Meeting ... 137
Invention, A Lost (?) ... 184
Invention in Great Britain, Germany and America ... 516
Iron and Its Early Manufacture in England. A. R. Bell 185
Iron and Steel from Corrosion, A New Process for the Protection of ... 112
Iron and Steel Institute, Notice of Annual Meeting ... 390
Iron, Effect of Ammonia on (How and Why 34) ... 390
Iron or Brass for Laying Out Work, To Prepare. Oliver E. Voris ... 414
Iron that Gave Us Leadership, The ... 23
Isometric Drawing, Triangle for. R. Grimshaw ... 386
Isometric Perspective, Notes on ... 74

Jackson, F. H.:
To Make Black Marks on Graduated Surfaces ... 655
Blacking Brass ... 444
Frosting Brass Work ... 495
To Write Black on Glass or Bright Metal ... 444
To Remove Bluing from Tempered Steel ... 605
The Use of Brass Wire in Brazing ... 605
"Jaymac":
Appliances for Boring, Facing and Turning Small Spur Gears ... 650
An Electrical Repair Job .. 652
Jenkins, J. J.:
High-Speed Steel in the Machine Shop of To-day 46
Jib Crane and Traveling Jib Drill, Traveling ... 625
Jib Crane, Load on a. Dyer Smith ... 568
Jig Blocks ... 433
Jig for Drilling Angle and Strap Iron. H. J. Bachmann ... 488
Jig for Spacing and Drilling Holes at a Given Angle. Julius Lenhart ... 215
Jig Maker:
Accurate Jig Making ... 270
Jig Making, Accurate. Frank Shaller ... 54
Jig Making, Accurate. J. R. Gordon ... 156
Jig Making, Accurate. Jig Maker ... 270
Jig Making, Accurate. J. R. Gordon ... 328
Jig Milling and Drilling. H. J. Bachmann ... 595
Jigs and Fixtures. How Defined ... 310
Jigs and Milling Fixtures with Operation Sheet. B. P. Fortin ... 265
Jigs and Tools for Machining Small Pistons. William N. Taylor ... 157
Jigs, Bushing for Drilling and Reaming. O. C. Bornholt ... 491
Jigs for Shafts, Simple Drilling. Herman Jonson ... 221
Jigs, Getting the Full Value Out of. J. F. Mirrielees .. 299
Jigs, Regarding Accuracy of. H. J. Bachmann ... 330
John Fritz Medal, The ... 477
Joint on Rough Surfaces by the Aid of Soft Metal, Making a. C. E. Mink .. 493
Jonson, Herman:
Cutting off Stock in Engine Lathes ... 221
Simple Drilling Jigs for Shafts ... 221
Non-Corrosive Soldering Fluid ... 495
Winding Springs ... 221
Polish for Brass. Polish for Steel ... 605
Transmission Rope Dressing ... 605
Construction of an Old Coffee Mill ... 653
Josselyn, C. E.:
Layout of Pitch Circles of Elliptic Gears ... 598
Journal Air Lubricated ... 52

Keyseating Bar for Shaper Use. J. T. ... 277
Keyseating Planer Attachment. C. P. L. ... 327
King, Patrick J.:
A Neat Screw Driver ... 220
King, R. P.:
Notes on the Strength of Beams, Plates, and Columns ... 526
Kingsley, E. P.:
Wire Straightener ... 220
Kleinhans, Frank B.:
Eccentric Loading ... 30
Bending Angles and Structural Shapes ... 306
Correction of a Calculation in "Eccentric Loading" . 354
Some Lathe Fixtures ... 101
Standard Hydraulic Pipe Flanges ... 618
Knavel, Albert D.:
Process for Pulverizing Borax ... 444
Knibbs Patent, Litigation over the ... 258
Krupp Works, Essen and the 6
Krupp Works, Wages in the. 86
Kryptol, A New Substance for Electric Heating ... 141
Kwartz, E.:
A Criticism ... 602

Labar, Alex. C.:
To Coat Zinc Sheet Black for Templet Work ... 331
Labor Saving Scheme for Making Drawings. C. W. Putnam ... 150
Lachmann, Robert A.:
Keeping a Lineshaft Clean 442
Some Points About Oiling. 442
Tools for Facing Work in the Lathe ... 160
Seen in a Jobbing Shop ... 552
To File a Sharp Scriber .. 597
A Pointer on Filing ... 601
Hack Saw Kinks ... 604
Lacing Belts ... 276
Lamp, A New Incandescent. 423
Lamp Suspension without Loose Wires, Portable ... 496
Landis, Ezra F.:
Carborundum Wheels ... 102
Lard Oil on Machinery, Don't Use. C. F. Emerson ... 653
Lathe, A Large Bardons & Oliver ... 13
Lathe Attachment for Turning Trolley Wheels. J. R. Gordon ... 47
Lathe, Bullard 36-inch Vertical Turret ... 367
Lathe Job, An Uncommon. Straightedge ... 596
Lathe Lead Screw, Length of Thread of (How and Why 31) ... 331
Lathe of the Turret Class, Improved ... 354
Lathe Rig for Turning Machine Handles. Draftsman 217
Lathe Rollers for Finishing Work (How and Why 13) 161
Lathes, Some English. James Vose ... 21
Lathe, The "Lefries" Precision. Dr. Alfred Gradenwitz ... 147
Lathe Tool, Radius. F. H. Whipple ... 437
Lathe Carriage for Screw Cutting, German. Robert Grimshaw ... 79
Lathe Dog for Heavy Cuts. J. Mayer ... 552
Lathe Dog, Safety ... 496
Lathe Features, Some. Frank B. Kleinhans ... 101
Lathe for Turning Cranks. G. L. F. ... 141
Lathe for Turning Ellipses . 372
Lathe Gearing Compensation for Change of Lead due to Hardening. Hans Dahlstrand ... 436
Lathe Gearing for Quick Pitches. J. T. ... 380
Lathe Tail Spindles, Boring Taper Holes in. E. H. Fish ... 651
Lathe with Quick Change Gear Device. Le Blond .. 22
Launching of the Connecticut ... 137
Launching of the New Jersey 208
Laying Out Cone Pulleys, Graphical Method of. John Swanberg ... 552
Laying Out Crown Brasses, Tool for. R. G. D. ... 219
Laying Out Right-Angle Channel on End of Steel Block (How and Why 55) 606
Laying Out Work, To Prepare Iron or Brass for. Oliver E. Voris ... 414
Layout of Pitch Circles of Elliptic Gears. C. E. Josselyn ... 598
Leak in a Tank, A Novel ... 257
Leather Belts, Glue for. L. E. Muney ... 495
Leather can be Crimped, How (Answer to How and Why 42) ... 552
Leather Medal, A. Carroll Ashley ... 150
Le Blond Lathe with Quick Change Gear Device ... 22
Lectures at the Brooklyn Polytechnic, Evening ... 320
Lehre, George J.:
Calculations for the Shaft Gear and Bearings of Crane Motors ... 565
Length of Thread of a Lathe Lead Screw (How and Why 31) ... 331
Lenhart, Julius:
Jig for Spacing and Drilling Holes at a Given Angle ... 215
Leonard, W. S.:
To Waterproof Glued Joints ... 495
Lettering Drawings, A Device for ... 8
Leveling Machine Tools, The Importance of. Sellem ... 97
Levin, A. M.:
Modern Steam Hoisting Machinery ... 453
Lifting Magnets for Handling Iron and Steel ... 363
Lifting Magnet, New ... 594
Lightening Conductors, On 371
Lindmark Steam Turbine, The ... 304
Lindsay, D.:
Boring Bar for Chasing Threads ... 153
Radial Attachment for Boring Bar ... 330
Radial Slotting Attachment ... 268
Lineshaft Clean, Keeping a. Robert A. Lachmann ... 442
Link Grinding Machine ... 313
Link Milling Attachment ... 647
Link Motion for Rotating a Shaft 180 Degrees ... 214
Litigation Over the Knibbs Patent ... 258
"Little Drummer" Record Cards ... 584
Lloyd's, The Beginning of .. 201
Loading, Eccentric. Frank B. Kleinhans ... 30
Load on a Jib Crane. Dyer Smith ... 568
Lobnitz Rock Cutter ... 148
Locating and Aligning Shafting and Machinery, A Handy Tool for. Wm. H. Brooks ... 76
Locating Pounds and Knocks. 319
Location of Decimal Point in Slide Rule Calculations (How and Why 56) ... 607
Lock, Hydraulic Lift ... 16
Locomotive Boiler Test Pump. A. E. Mitchell .. 442
Locomotive, First Transcontinental ... 85
Locomotives as Fog Makers. 602
Locomotives in Germany, Superheated Steam for ... 36
London Underground System, Note on the ... 366
Longest Pipe Line ... 160
Loose Pulley Design for High Speed. James A. Pratt ... 435
Loose Pulleys. Bristol ... 490
Lord, J.:
Making T-Slot Cutters .. 323
Lost, an Engine ... 85
Lotz, F. P.:
The Designing and Making of Bells ... 295
Lubricant for Drawing Dies. J. M. Stabel ... 605
Lubricants, A Novel Process for Testing. Dr. Alfred Gradenwitz ... 415
Lubricating Oil from Pine Stumps ... 201
Lubricating Soap for Wire Drawing, Screw Cutting and Working Metals. A. F. Bierbach ... 444
Lubrication, Improved ... 310
Lubrication, Necessity of .. 200
Lubrication of Springs; Is it Desirable? ... 370
Lubrication System, Forced Grease ... 482
Lucas, J. L.:
Cold Tinning Process for Use on Finished Work in Iron, Brass or Steel .. 675
Lutes and Cements, Notes on. 296

Machine for Testing the Lubricating Qualities of Oils ... 524
Machine Handles, Lathe Rig for Turning. Draftsman. 217
Machine Operation, Phenomena of ... 536
Machinery, Don't Use Lard Oil on. C. F. Emerson 653
Machinery from Rusting, To Keep. James A. Pratt 495
Machinery, Large Special . 257
Machinery, The Transition Period in ... 208
Machining a 10-foot Gear. Geo. Rennicsen ... 322
Machining Small Pistons, Jigs and Tools for ... 157
Machinist's Protractor ... 482
Magnetic Alloys Made from Nonmagnetic Metals ... 423
Magnetic Clutch Shifter. Herbert S. Gladfelter ... 271
Magnets for Handling Iron and Steel, Lifting ... 363
Maine, Raising the ... 258
Making Oxygen from Liquid Air ... 585
Manganese Rails for Sharp Curves ... 493
Manganese Steel, Notes on 359
Manierre, J. E.:
To True Universal Chuck Jaws ... 214
Mann, W. L.:
Dimensions of Ells and Tees for Wrought Iron Pipe ... 529
Man Who is the Whole Thing, The. C. M. C. ... 100
"Man Who is the Whole Thing, The." Foreman .. 321
Marcellus, V. H.:
To Harden Thin Saws Without Warping ... 491
Adjustable Hollow Mill .. 51
Spring Strippers Construction ... 272
Blanking and Forming Dies ... 649
Marine Craft in America, Slow Construction of ... 139
Marine [illegible] in ... 378
Marine [illegible] tection of [illegible] ... [illegible]
Markham, E. R.:
Tool Making
17, 80, [illegible] 501
Mathien, J.:
A Simple Indic[illegible] ... 277
Mat Surface on S[illegible], To Produce a. M. J. [illegible] ... 655
Mayer, J.:
Lathe Dog for Heavy Cuts 552
May, John Mark:
Advice to Apprentices .. 434
McAnie:
Should Machines be Bolted Down? ... 324
Wonderful Taps and Dies 150
Something on the Heat Question as Affecting the Accuracy of Machine Operations ... 549
Meade, Norman G.:
Electric Repairing
187, 249, 307
Repairing Field Coils . 529
Measure the Radii of Deephole Drills, To. Otto Eckelt ... 298
Measuring Instruments, Some Micrometer. A. L. Monrad ... 41
Mechanical Courses at Y. M. C. A. ... 137
Mechanical Engineering, Shop Training for. H. P. Fairfield ... 517
Mechanical Movement, An Ingenious. R. E. Flanders 489
Mechanical Movement, A Novel ... 634
Mechanical Science, Some Refinements of ... 243
Mechanical Toys, Badly Made ... 257
Mechanisms, Variable Speed.
I. ... 458
II. ... 508
III ... 561
IV ... 616
Medal, A Leather. Carroll Ashley ... 150
Medal, The John Fritz ... 477
Melting Steel with Cast Iron 586
Melville, David:
Cement for Iron ... 605
Rust Joint ... 655
Mertes, A.:
Something More Regarding Idle Machines ... 95
A Taper Roughening Reamer ... 95
Time-saving Chucks ... 95
Metals, Cement for. H. S. Gladfelter ... 655
Metals, The Steel Hardening. Jos. Hyde Pratt ... 473
Method of Securing Trade of Naxos Union Makers of Emery Wheels ... 637
Metric Leadscrew, Cutting English Threads with. A. L. Valentine ... 440
Meyers, L.:
Etching Solution ... 444
Michel, A. Eugene:
Roller Chain Power Transmission and Construction of Sprockets ... 287
Micrometer Beam Caliper, Improved ... 648
Micrometer Depth Gage, An Addition to the B. & S. C. W. Shelly ... 654
Micrometer for Test Bars, Foundry ... 371
Micrometer Gage for Milling Cutters. Robt. Grimshaw 443
Micrometer Gage, Six-inch. L. Norden ... 548
Micrometer Measuring Instruments, Some. A. L. Monrad ... 41
Middlemen in Japan ... 201
Mill, Adjustable, Hollow. V. H. Marcellus ... 51
Miller, George:
Gas Engine Economy ... 305
Milling a Large Screw. H. A. Houghton ... 384
Milling and Drilling Jig. H. J. Bachmann ... 595
Milling Attachment, Link . 647
Milling Cutters, Micrometer Gage for. Robt. Grimshaw 443
Milling Cutters, The Shaping, Grinding and Hardening of 205
Milling Cutters with Teeth Cast in. W. [illegible] ... 655
Milling Flat Forming Cutters. W. F. [illegible] ... 602
Milling Floor Girder Bases. J. C. Spence ... 321
Milling Machine Attachment for [illegible] Wheels. [illegible] ... 165
Milling Machine, Improvised Vertical. Charles F. Burns ... 328
Milling [illegible] Teeth. Draftsman ... 221
Milling Square [illegible] Head Screws ... 648
[illegible] End [illegible] Heads. [illegible] W. C. F. ... 491
[illegible] Gages [illegible] Catches. Why [illegible] ... [illegible]
Mink, C. E.:
Cement for [illegible] Cracks in Castings ... 605
Solution for [illegible] Hard Steel ... 495

Making a Joint on Rough Surfaces by the Aid of Soft Metal ... 493
Sulphur as a Packing Between Bed Plates and Foundations ... 435
Covering Pulleys with Leather ... 596
Mixture for Fire Cement. 605
Minnesota, The ... 25
Mirrielees, J. F.:
Getting the Full Value Out of Jigs ... 299
Mitchell, A. E.:
Compressed Air as an Aid to Fan Blast in Forge Shop ... 437
Locomotive Boiler Test Pump ... 442
Handy Water Connection for Car Wheel Press.. 443
Modern Steam Hoisting Machinery. A. M. Levin.... 453
Modern Work with Ancient Tools. E. J. Buchet.... 649
Molder, Making a ... 639
Monrad, A. L.:
Some Micrometer Measuring Instruments ... 41
Muffle Brazing ... 103
Monument to Eli Whitney. 84
Mortar for Stopping Holes in Boiler Settings, etc. F. Emerson ... 655
Motor Drive as Applied to Cotton Mills ... 585
Motor-driven Fire Engines in Vienna ... 533
Motors and Dynamos, Small. E. E. Warner ... 438
Motors on Fishing Boats.. 84
Motors to Machine Tools, Application of ... 372
Motor Drives for Old Tools. 406
Motors, Gasoline ... 85
Motors, Variable Speed. Wm. Baxter ... 513
Mottle Casehardened Pieces, To. Harry Ash ... 331
Mottling Casehardened Work 144
Muffle Brazing. A. L. Monrad ... 103
Multiple Threads with a Chaser, Cutting. T. E. Remington ... 330
Multi-Stage Centrifugal Pumps for Elevator Service ... 583
Muncy, L. E.:
Chuck for Holding End Mills ... 105
Glue for Leather Belts... 495
For Bluing Small Brass and Steel Articles by Immersion ... 605
Myers, John S.:
Beams and Planes with Several Supports. A Criticism ... 30
On the Strength of Timbers ... 322
Charts in Designing— 9, 90, 145
Myers, L.:
Tool for Boring Rotary Pump Casing ... 440

Name Plates, Concerning.... 612
National Machine Tool Builders' Association 471
National Machine Tool Builders' Convention ... 181
National Machine Tool Builders' Convention, Next 331
Neat Method of Keeping Screws ... 352
Neil, C.:
A Turret Parting Tool.. 441
New Anti-Friction Metal, The ... 500
New President for Lehigh University ... 612
New Tools of the Month.... 56
(2) ... 108
(3) ... 162
(4) ... 223
(5) ... 279
(6) ... 332
(7) ... 392
(8) ... 446
(9) ... 499
(10) ... 554
(11) ... 608
(12) ... 658
New York Subways, Proposed 312
Niagara Falls, Power Station at ... 423
Niagara Power Houses, Sizes of the Three New ... 423
Niagara Water Power ... 534
Nickel for Coinage, Use of Pure ... 637
Nickel Steel, Use and Value of 290
Niemand, L. B.:
Test Gage for Maintaining Standard Tapers ... 220
Non Corrosive Soldering Fluid Herman Jonson ... 495
Norden, L.:
Six-Inch Micrometer Gage. 548
Not as Rich as We Seem.... 24
Number Plates, Punch and Die for Making. W. Van Orman ... 50
Nut Locks ... 86

Oehes, Max J.:
To produce a Mat Surface on Steel ... 655
Office Building, A New Sturtevant ... 300
Oil Filter, German ... 648
Oil Grooves and the Fitting up of Bearings. C. H. Bierbaum ... 459
Oil in Boiler Furnaces, Danger of ... 533
Oiling, Some Points About. Robert A. Lachmann...... 442
Oil Stones, To Mend Broken.
Oil Grooves and the Fitting up of Bearings. C. H. Bier-
O. M. Becker ... 442
Oily Steel, Copper Solution that will Color on ... 655
Old Tools, Motor Drives for. 406
One-Turn Clutch. John D. Adams ... 598
Oscillating Engine, Counterbalancing an ... 632
Otis, Robert B.:
Using a Hacksaw as a Parting Tool in the Lathe 222
Using a Tap as a Reamer 161
Otto, F. H.:
To Blacken Brass for Templet Work and Other Purposes ... 195
Our Record of New Tools.... 422
Output of a Machine, A Small Change that Made a Big Improvement in ... 389

Pacific Steamships Minnesota and Dakota ... 55
Page, Julian D.:
Checking a Drawing ... 382
Making a Core Box from the Pattern ... 158
Panama Canal Problem, The 245
Panama Canal, The ... 405
Panama, Regulations for Employees at ... 422
Paradox, The Telephone.... 33
Parallel Motion for Drawing Board. H. M. B. ... 215
Parting Tool in the Lathe, Using a Hacksaw as a. Robt. B. Otis ... 222
Patent Issued in 1828, Copy of a ... 404
Patent Laws, Proposed Revision of the ... 25
Patent Law, A Strange.... 415
Patent Laws, Stricter British 140
Patents. Some Facts Concerning ... 416
Patterns for Chuck Plates. E. H. Fish ... 51
Pattern Shop of the U. S. Naval Gun Factory. Edwin M. Birrell ... 241
Peary's New Arctic Ship, Machinery and Hull of ... 580
Peat Gas as a Source of Power 477
Peat, Recuperative Power of 141
Pennies doing the Work of Dimes ... 85
Pennsylvania Tunnel, Progress on the ... 403
Percy, E. N.:
The Practical Inspector... 69
Engines for U. S. Armored Cruisers 6 and 9 ... 198
Something about Aluminum 413
Permanent Iron Cement for Steam Pipes. J. H. Taylor 495
Perpendicularity, The Sense of ... 443
Perrigo, Oscar E.:
The Use of Distinctive Colors ... 364
Punch and Die for Making Square Nuts ... 492
An Example of Worm Gearing ... 525
Tool Carriers ... 575
Reply to "A Criticism"... 602
Personal Reminiscences, Some. Joseph H. Springer, Sr... 551
Perspective, Notes on Isometric ... 74
Perspective, The Practical. Fred H. Colvin ... 45
Petroleum Briquetting ... 33
Phenomena of Machine Operation ... 536
Philadelphia—
Fixture for Boring Brasses 159
Milling Machine Attachment for Threading Worm Wheels ... 160
Photographing Shop Interiors 84
Photographs of Steam Turbine Blades, Interesting.. 471
Photography, Value of.... 136
Piecework Shops, A Problem for the ... 257
Pile Drivers, Superiority of Drop Hammer for ... 139
Pillow-block Seat of a Large Engine was Planed out with a Small Planer, How the. E. J. Buchet ... 218
Pins Used in Chord System of new Blackwell's Island Bridge, N. Y. ... 530
Pipe Center. Francis W. Shaw ... 442
Pipe Centers. J. T. ... 277
Pipe Fishing Job, A. Otis D. Storer ... 604
Pipe Flanges, Standard Hydraulic. F. B. Kleinhans. 618
Pipe-Joints for High-Pressure ... 317
Piston Rings, Making. Steel 155
Piston Rings, Rig for Re-Turning. Stanley Gould.. 488
Pitch for Road-making ... 139
Planer and Lathe Cutter and Boring-Bar. A. B. C. ... 387
Planer, A Portable Home-made ... 371
Planer Bar with Stiff Support. F. Emerson ... 96
Planer Drive, New Cushion. 371
Planers, High Speed. A. L. De Leeuw ... 501
Planer with Air-operated Friction Clutches, Ninety-six Inch Sellers ... 365
Planing a Cross Groove. Eugene Wopaletzky ... 161
Planing Engine Beds. F. H. J. ... 442
Planing Keyways in Shafts, V-blocks for ... 433
Planing Spiral Corrugated Rolls. W. L. Fay ... 274
Planing Thread Tools, Formula for. A. L. Valentine. 489
Plans for the Carnegie Engineering Building ... 137
Plate Planers, Double-Head Tool for. Toolmaker 443
Plenum Heating System and Coke Air Washing Apparatus of B. F. Sturtevant Co. 529
Plotting Curve from an Inaccessible Center, Method of 87
Plug Gage Construction, Improved. W. E. G. ... 99
Plugging Holes in Cast Iron, Mixture for. R. B. Casey. 495
Pneumatic Tube System, Proposed Long-distance ... 359
Pointer on Filing, A. R. A. Lachmann ... 604
Polish for Brass—Polish for Steel. Herman Jonson.... 605
Porous Casting Air- and Water-tight, Mixture for Making a. L. S. Burbank.... 444
Portable Home-made Planer, A 371
Portable Lamp Suspension without Loose Wires 496
Portland Cement, Effect of Oil on ... 545
Portland Cement When Mixed With Water, Properties of 477
Port Richmond Iron Works, Heavy Work of the ... 233
Post-box on the Principle of Coin-in-the-slot Machine .. 20
Power Hoist, Weight Needed on Lever of a (H. & W. 26) 278
Power in Street Railway Service, Cost of ... 317
Power Plant of the Hotel Astor ... 85
Power Plants, Vertical Boilers in ... 199
Power-transmission by Frictional Gearing (H. & W. 21) ... 277
Practical—
Dies for Making Tin Nozzles 487
Practical Don'ts for Machinists. H. E. Wood ... 530
Practical Inspector, The. E. N. Percy ... 69
Pratt, James A.:
Estimating Cost, with Examples Illustrating Application of Method ... 71
Cutting and Applying Gaskets ... 494
To Keep Machinery from Rusting ... 495
Loose Pulley Design for High Speed ... 435
The Steel Hardening Metals 473
Applying Asbestos ... 604
Varnish for Cast Iron Patterns ... 605
Precision Gage ... 496
Precision Screw, Standard... 424
Prepare Iron or Brass for Laying Out Work. Oliver E. Voris ... 444
Press, A. P.:
How Bill Changed His Job 151
A Vacation and What Came of It ... 45
"A Bluff that Went"..... 601
Pressure of Modern Guns, Enormous ... 647
Press with Special Feed, Bliss 644
Preventing Vibration in Steamships, Method of... 538
Prick Punch Holder. M. H. Ball ... 160
Prick Punch with Adjustment, Automatic. Otis D. Storer ... 381
Prick Punch with Interchangeable Scriber Points. C. C. Arras ... 604
Prime Movers, Comparisons and Notes on ... 313
Problem for the Piecework Shops, A ... 257
Producer Gas Engines on Shipboard ... 373
Production of Light, Energy Expended in ... 637
Projection, Anisometric. Robert Grimshaw ... 492
Properties of Portland Cement When Mixed with Water ... 477
Proportions and Character of Sand and Gravel to Use in Concrete ... 530
Proportions of Twist Drills. H. D. ... 646
Proportions for a Cast-iron Spring Piston Ring (H. & W. 38) ... 445
Proposed Revision of the Patent Laws ... 25
Protection of Iron and Steel from Corrosion, A New Process for the ... 142
Protective Devices in Shops. 586
Protractor, Machinists' 482
Pulley Crowning Device. Theo. Disch ... 491
Pulleys, Loose, Bristol.... 490
Pulleys, The Bursting Strength of Wooden. C. H. Benjamin ... 613
Pulverizing Borax, Process for. Albert D. Knavel ... 444
Pumping Engine, A. Worthington ... 90
Pumping Heavy Fluids..... 406
Pumping in Mexico ... 402
Pumping Machinery, The Limit in ... 636
Pumps, The Action of ... 34
Punch and Die, Adjustable, to Cut Sectors of Various Lengths. H. J. Bachmann 387
Punch and Die for Making Number Plates. W. Van Orman ... 50
Punch and Die for Making Square Nuts. O. E. Perrigo 492
Punch and Die for Steel Range Work, Compound. W. Van Orman ... 271
Punch for the Manufacture of Washers and Specialties 470
Punching Die for Making Labels. Paul R. Werner.. 269
Punching Small Holes in Tool Steel Blanks. Joseph V. Woodworth ... 419
Putnam, C. W.:
Labor-saving Scheme for Making Drawings ... 49

Quenching Baths for Tempering Cutting Tools, Composition of ... 478
Questions, The Doubtful Joy of Answering ... 422
Quick Action Bench-Vise.... 83
Quick Change Gear Device, Le Blond Lathe with.... 22
Quick Job, A ... 130
Quick-return Shaper Motion. E. H. Fish ... 97
Quick Pitches, Lathe Gearing for ... 380
Quivering in Machine Tools, To Prevent ... 476

Radial Attachment for Boring Bar. D. Lindsay..... 330
Radial Slotting Attachment. D. Lindsay ... 268
Radii of Deep-hole Drills, To Measure the. Otto Eckelt 298
Radium and Energy ... 79
Radium, New Theories Concerning ... 424
Radius Lathe Tool. F. H. Whipple ... 437
Railway, First American Alternating Current ... 84
Railway Trains, Resistance of. G. L. F. ... 35
Raising the Maine ... 258
Ramp, J. B. (Obituary) ... 144
Rams of Boring Mills, Balancing Arrangement for the 202
Rautenstrauch, Walter:
Notes on Riveted Joints... 401
Raymond, Prof. W. G.:
Increase in Engineering Courses ... 423
Razors, High Speed Steel... 256
Real Efficiency of Steam Boilers, The ... 587
Reamer, A Taper Roughening. A. Mertes ... 95
Reamer Extensions, Two.... 220
Reamer, Using a Tap as a. R. B. Otis ... 161
Receiving Mechanism, Delicate ... 119
Reciprocating Parts in Engines, Result of Reducing. 139
Recording Angular Velocities of Marine Shafting ... 590
Record of New Tools, Our... 422
Recuperative Power of Peat. 141
Recut Old Files, To. R. B. Casey ... 391
Redrawing Dies Economically, Making. C. F. Emerson 436
Red Tape, Some Simple. E. H. Fish ... 628
Reduce Presure to Save Gas 87
Refinements of Mechanical Science, Some ... 243
Reducing Sleeve for Pump Cylinders ... 604
Refrigerating Plant for Every House, A ... 257
Reinforced Concrete ... 588
Reinforced Concrete Piles... 368
Relative Cost of Cutting by Emery Wheels and by Filing 141
Relieving the Teeth of Hand Taps. (H. & W. 54) ... 606
Remedy for Injured Steel... 88
Remington, T. E.:
Cutting Multiple Threads with a Chaser ... 330
Reminiscences, Some Personal. Joseph H. Springer, Sr. 551
Renneisen, Geo.:
Machining a 10-foot Gear. 322
Repairing a 400-Ton Hydraulic Press. Frank M. Davis 630
Repairing Commutators in which the Mica Insulation has Burned Away ... 645
Repairing, Electric. Norman G. Meade:
(1) The Commutator 187
(2) Armature Winding... 249
(3) Armature Coils 307
Repairing Field Coils. Norman G. Meade ... 529
Repair Job, An Electrical. "Jaymac" ... 652
Repair Jobs, Emergency.... 636

Re, Pedro:
Striking up Forming Dies. 384
A Tapping Experience.... 276
Repetition Castings, Gang Milling of, J. V. Woodworth 582
Reply to "A Criticism." O. E. Perrigo 602
Report on Black Powder by Chief Mason of Bureau of Ordnance 472
Research, Steam Engine 483
Resistance of Emery Wheels to Rupture, The......... 35
Resistance of Jacketed Bullets when Forced through the Bore of 0.30 Caliber Rifle Barrels 635
Resistance of Railway Trains. G. L. F. 35
Result of Reducing the Weight of Reciprocating Parts in Engines........ 139
Retirement of George A. Gray of Cincinnati, Ohio...... 476
Re-turning Piston Rings, Rig for. Stanley Gould...... 488
Rewinding of Armature..... 486
Ridgway Machine Tool Co., New Plant of the........ 407
Rifle Gun, Ball-bearing...... 32
Rifle Sight, A New......... 85
Riley, Joseph C.:
A Process for Copying Printed Pictures 5
Riveted Joints, Notes on.... Walter Rautenstrauch ... 401
Road-Making, Pitch for.... 139
Rolled Steel Car Wheels.... 427
Roller Chain Power Transmission and Construction of Sprockets. A. Eugene Michel 287
Rolling Process. To Make Gear Wheels by a....... 497
Rolls for Cylinder Cams, On the Shape of. R. E. Flanders 209
Ropes in Mines........... 12
Rosenthal, L. S.:
Turret Tool Holder....... 159
Rotary Pump Casing, Tool for Boring. L. Myers.... 440
Rotating a Shaft 180 Degrees, Link Motion for. J. D. Adams 214
Rotation of Marine Propeller Wheels, Direction of.. 137
Rough Castings, A System of Drill Jigs for. H. J. Bachmann 209
Rowe, C. H.:
Regarding the Teeth of Hollow Mills 215
Rubber Industry Statistics.. 418
Rules for Calculating Speed Reduction and for Finding the Number of Teeth of the Gears that will give a Desired Ratio 445
"Run of Stone," Value of a. H. & W. 9)............ 107
Rust Joint. D. Melville.... 655
Rust Joint Mixture........ 33

Safety Catches? Why do not Mining Cages have....... 85
Safety Device for Setscrews, Simple. Warren E. Willis 442
Safety Lathe Dog.......... 496
Salt-water and Boiler Scale. 184
Sand Blast Apparatus for Cleaning Tenders 89
Saws without Warping, To Harden Thin. V. H. Marcellus 494
Scientific and Engineering Supplement to be Published with London "Times," Weekly 390
Scranton Meeting of the A. S. M. E. 593
Screw Cutting, German Lathe Carriage for. Robert Grimshaw 79
Screw Cutting Kink. Eugene Wopaletzky 159
Screw Cutting with the Feed Gear. J. T............. 104
Screw Driver, A Neat. Patrick J. King............ 220
Screw Machine, Self-aligning Holder for 388
Screw Machines for Thread Cutting, Camming. G. H.. 388
Screw Thread, Callipering the Fit of a. H. E. Wood... 275
Sears, W. T.:
To Harden Cast Iron.... 444
To Keep Water from Freezing or Souring......... 444
Hydraulic Valve Improvement 270
Sectional Fixture, A. Ralph E. Flanders 93
Securing Inserted Blades, Method of 425
Seen in a Jobbing Shop. R. A. Lachmann 552
Segment Gears, Facing. H. G. 221
Self-aligning Holder for Screw Machine. C. M. Dall...... 388
Sellem:
The Importance of Level ing Machine Tools..... 97
Sensitive Governing under High Heads 86
Sepia and Blue-print Paper. (H. & W.).............. 54
Setscrews, Simple Safety Device for. Warren E. Willis 442
Setting for Turning Tapers. J. T. 52
Sewing Machine which Sews Direct from Two Spools of Thread 637
Shaft Coupling of The Republic Engineering Co. ... 644
Shafts, Connecting (H. & W. 8) 107
Shailor, Frank E.:
Notes on Toolmaking..... 210
Accurate Jig Making..... 51
Re-cutting Thread Chasers 104
Gage Making........... 546
Shape of Rolls for Cylinder Cams, On the. R. E. Flanders 209
Shaper Tools, Device for Preventing Wear of. A. R. Chern 98
Shaping, Grinding and Hardening of Milling Cutters, The 205
Sharp Curves, Manganese Rails for 423
Shaw, C. J.:
Graduating for Degrees in the Index Head....... 442
Shaw, Francis W.:
Pipe Center 442
Shear Steel, Method of Making 232
Shee, Park B.:
To Reduce Small Drill Breakage 494
Hot Water for the Tin Shop 277
Sheily, C. W.:
Making Drop Forging Dies 266
An Addition to the B. & S. Micrometer Depth Gage 654
Sherardizing Process for Galvanizing Iron, New....... 637
Shop Arrangement and Cost of Output 138
Shop Cost Troubles, More. Jayonac 414
Shop Interiors, Photographing 84
Shop Training for Mechanical Engineering. Howard P. Fairfield 517
Shopwork Instruction 532
Should Machines be Bolted Down? McAnic 324
Shrinkage Allowance in Drop-Forging Dies for Copper. (H. & W. 43)........... 498
Shrinking Nuts or Rings for Permanent Set. C. D..... 159
Signaling in Australia, New System of 140
Silver Paste for Brass. J. S. Gordon 391
Simple Ball Reamer 104
Simple Drilling Jigs for Shafts. Herman Jonson.. 221
Simplicity of Electric Furnace Processes 607
Six-Inch Micrometer Gage. L. Norden 548
Sketching Camera, A. Warren E. Willis........... 326
Slide Rule, The—Position of the Decimal Point. S. E. Woodbury 189
Sliding Keyways, Friction of. James Arthur 218
Sliding Keyways, Friction of. 168
Slotter as a Machine Tool, The 476
Slow Construction of Marine Craft in America........ 139
Small Drill Breakage, To Reduce. P. B. Shee....... 494
Smallest Electric Motor Made 139
Small Motors as Generators. (H. & W. 46).......... 498
Smith, Dyer:
Load on a Jib Crane..... 568
Smoke and its Abatement.... 590
Soften Hard Cast Iron for Drilling, To. O. E. Voris 605
Solder for Brass and Steel, Non-rusting. (H. & W. 1) 54
Soldering Acid and Solders. A. 495
Soldering Aluminum. R. E. Weinland 494
Soldering Aluminum Patterns 627
Soldering Copper Conductors, Notes on. G. L. F....... 478
Soldering Fluid, Non Corrosive. H. Jonson......... 495
Soldering Fluid, Non-Rusting. F. E. Whittlesey........ 444
Solders for Steel Brazing, Hard 311
Solution for Beams, Graphical 214
Solution of Question No. 55, Simple. A. L. DeLeeuw.. 656
Solution of the Bevel Curve. Charles Clonkey 93
Something About This Department 605
Special Counterbore. W. C. Force 652
Specific Heat of Superheated Steam 521
Speed and Material for Steel Gears. (H. & W. 20)... 222
Speed in Wood working Machinery 33
Spence, J. C.:
Milling Floor Grinder Bases 321
Spherical Boring and Turning in the Allis Chalmers Shops 574
Spiral Corrugated Rolls, Planing. W. L. Fay..... 274
Sports, Indifference of German Workmen to 87
Spring Dies Closing In, To Prevent. W Van Orman 105
Spring Latch, Making a. H. R. H. 152
Spriog Strippers Construction. V. H. Marcellus.... 272
Spur Gears, "Angle of Pressure" of 334
Spur Gears, Appliances for Boriog, Facing and Turning Small. Jaymac...... 650
"Spur Gear Teeth, Giving Diametral Pitch, Table of": A Correction....... 383
"Spur Gear Teeth Giving Diametral Pitch, Table of." Error Corrected in....... 276
Spur Gear Teeth Giving Diametral Pitch, Table of. L. S. Burbank.......... 212
Spirally Corrugated Boiler Tube, A 86
Springer, Sr., Joseph H:
Some Personal Reminiscences 551
Square Nuts, Punch and Die for Making. O E. Perrigo 492
Square Thread Screws, Milling 648
Square Thread Taps in Sets. 379
Stabel, J M.:
Lubricant for Drawing Dies 605
To Prepare Emery for Fine Lapping 494
Paste for Hardening High-Speed Steel 495
An Expansion Chuck..... 549
Tables Giving Angles of Threading Tools 599
Varnish for Steel....... 605
To Blacken Brasswork for Instruments 655
"Standard" Nose Threads for Lathe Spindles. James Arthur 95
Standard Precision Screw... 424
Standard Tapers Test Gage for Maintaining. J. B. Niemand 220
Starting and Regulating Rheostats for Machine Tool Drives 500
Statistics of the World's Output of Coal.......... 467
Statistics, Rubber Industry. 418
Staybolts, Braces and Flat Surfaces 263
Staybolts for Oil burning Boilers, Radial 203
Steam and Electric Traction Compared 90
Steam Boilers, The Real Efficiency of 587
Steam Engine Research..... 483
Steam in Nozzle of a Turbine. (H. & W 7)........ 54
Steam Pipes and Boilers, Insulating Covering for. Theodore Disch 444
Steam Pipes, Permanent Iron Cement for. James H Taylor 495
Steam Pipes, Water Hammer in 37
Steam Roll Necks, Device for Turning. Otis D Storer.. 438
Steam Turbine be Started in an Emergency Quicker than a Reciprocating Engine of the Same Power? Can a. 592
Steam Turbine Blades, Interesting Photograph of..... 471
Steam Turbines, Condensers for 260
Steam Turbine Construction, The Trend in........... 24
Steam Turbine, The Hamilton Holzworth 131
Steam Turbine, The Lindmark 304
Steam Turbine Patents, A Review of
(1) 1
(2) 115
(3) 237
(4) 291
Steel:
Making Piston Rings ... 155
Steel Brazing, Hard Solders for 311
Steel Cage Building Construction 640
Steel Can be Cut Faster than Cast Iron, Why 625
Steel, Coloring. Harry Ash. 391
Steel-concrete Construction.. 86
Steel Forging and Tempering, Tool. R H Henderson.. 67
Steel Gears, Speed and Material for. (H & W. 20). 222
Steel Hardening and Tempering Compound H S Hindman 444
Steel Hardening Metals, The Jos Hyde Pratt....... 473
Steel, High Speed 85
Steel, Increased Consumption of 477
Steel Mills, Electric Motors in 544
Steel Production Per Annum 33
Steel Range Work, Compound Punch and Die for. W Van Orman 271
Steel Scale Handy Screwdriver 619
Steels Suitable for Various Tools 423
Steel, Thermal Conductivity of Low and High-Carbon. 201
Steel Tracks for City Traffic, Failure of 201
Steel tired Wheels, Advantages of 477
Stegeman, Oscar:
Directions for Drawing R. C Coils 174
Still Safe, The Connecticut. 138
Storage Battery, New Type of 533
Storer, Otis D:
Automatic Prick Punch with Adjustment 384
Device for Turning Steam Roll Necks 438
A Pipe Fishing Job 604
"Straightedge"
An Uncommon Lathe Job. 596
Straighten Bruised Threads, To 389
Street Car Used in Cincinnati 639
Strength of Beams, Plates and Columns, Notes on the R. P. King 526
Strength of Beams with Ribbed Sections A Paradox 176
Strength of Columns, The.. 428
Strength of Steel, Effect of High Temperature on the. 257
Strength of Timbers, On the. John S. Myers.......... 322
Strength of Timber Treated with Creosote or Zinc Chloride, The 477
Strength of Tobin Brass Alloys 520
Striking up Forming Dies. Pedro Re 384
Sturtevant Economizer 106
Sturtevant Office Building, A New 300
Sturtevant Co., B F Plenum Heating System and Coke Air Washing Apparatus of the.......... 529
Subterranean Fires 70
Subway Employees 53
Subway Notes Worth Preserving 182
Subways, Proposed New York 312
Successful Apprentice, A .. 369
Suction Gas Producer, Design and Operation of..... 535
Sulphur as a Packing Between Bed Plates and Foundations. C. E. Mink 435
Sulphur Deposits at Calcasieu Parish, La., Working of 477
Summer School for Artisans, 5th Annual Session 475
Superheated Steam for Locomotives in Germany 36
Superheated Steam, Specific Heat of 521
Surgery, Simple Eye........ 119
Swanberg, John:
Graphical Method of Laying Out Cone Pulleys.. 552
Sweet, Prof. John E.:
The Apprenticeship Question 52
System of Drill Jigs for Rough Castings, A H J. Bachmann 209

Table of Spur Gear Teeth Giving Diametral Pitch L. S Burbank 212
Table of Tangents, To Lay Out Angles from 220
Tables Giving Angles of Threading Tools Jos M. Stabel 599
Tables Showing the Successive Events in Three and Four Cylinder Gas Engines R. L. Williams 435
Tap as a Reamer, Using a Robert B Otis.. 161
Tantalum 520
Taper Roughing Reamer, A A. Mertes 95
Tapers, Setting for Turning J. T. 52
Tapping Experience, A Pedro Re 276
Taps and Dies, Wonderful McAnle 150
Taps in Sets, Acme 268
Taps in Sets, Square Thread H D 379
Tariff on Machine Tools, German Manufacturers Demand 139
Taylor, Charles G.:
Three-piece Ellipsograph A Criticism 386
Taylor, J H.:
Permanent Iron Cement for Steam Pipes 495
Taylor, Wm. N.:
Jigs and Tools for Machining Small Pistons .. 157
Technical Education, Contemporary 245
Technical Publicity Association 542
Technology Club of Syracuse, N Y 85
Teeth Cast in, Milling Cutters with. W L. Fay...... 6
Teeth in Gears as Used in Rolling Mills, the Forms and Relative Advantages of 485
Teeth of Hollow Mills, Regarding the C H Rowe 215
Telephone Paradox, The .. 33
Temper Cold Chisels, To. (H & W. J. P. D.) 553
Tempering Circular Saws Used in Cutting Metals, Receipt for (H. & W 47). 552
Tempering Cutting Tools, Composition of Quenching Baths for 478

Terminal Facilities, Inadequate 430
Test Gage for Maintaining Standard Tapers. I. B. Niemand 220
Testing Gas Engine 376
Testing Krupp Guns in a Tunnel 637
Testing Lubricants, A Novel Process for. Dr. Alfred Gradenwitz 415
Testing Lubricating Qualities of Oils, Machine for 524
Test Pump, Locomotive Boiler. A. E. Mitchell 442
Tests of Helical Springs 624
Tests on High Speed Steel 175
The Minnesota 25
Theories Concerning Radium, New 424
The Possibilities of Bog Fuel 256
The Progress of the Connecticut 200
Thermal Conductivity of Low and High-Carbon Steel 201
Thermit Welding Locomotive Frames 645
The Trend in Steam Turbine Construction 21
Thiel, Charles:
Making Formed Cutters on the Lathe 216
Thread Chasers, Recutting. Frank E. Shailor 104
Thread Drawn from Melted Quartz 264
Thread Gages, The Grinding of. J. R. Gordon 78
Threading Worm Wheels, Milling Machine Attachment for 160
Threads on a Metric Lathe, Cutting English System .. 330
Thread Tools, Formula for Planing. A. L. Valentine 489
Three and Four-Cylinder Gas Engines, Tables Showing the Successive Events in. R. L. Williams 435
Three M's, The 319
Three-piece Ellipsograph Again. John D. Adams .. 491
Timber Preserving Plant ... 199
Timbers, On the Strength of. J. S. Myers 322
Timber, Treated with Creosote or Zinc Chloride, Strength of 477
Time-saving Chucks. A. Mertes 95
"Times" Building, The New. 311
"Times" New Engineering and Scientific Supplement, London 390
Tinning Wire Goods, Process for. (H. & W. 51) 606
Tin Nozzle, Dies for Making, Practical 487
Tobin Brass Alloys, Strength of 520
Tool-Carriers. Oscar E. Perrigo 575
Toolmaker—
Double-Head Tool for Plate Planers 443
Toolmaker's Files, by American Methods, The Making of Fine 431
Toolmaking.—E. R. Markham:
(10) Arbors 17
(11) Drills 80
(12) Forming Tools and Milling Machine Cutters 190
(13) Milling Machine Cutters 252
(14) Milling Machine Cutters 301
Toolmaking, Notes on. Frank E. Shailor 210
Tool-rest on American Lathes, Defective Design of 637
Tools for Facing Work in the Lathe. Robert A. Lachmann 160
Tools, Modern Work With Ancient. E. J. Buchet ... 649
Tool Steel Forging and Tempering. R. H. Henderson. 67
Track Inspection Apparatus. 12
Traction Wheels of Electric Motor Cars, Effect of 604
Trade Mark Bill, New 366
Trades and Faces 144
Transformer of High Voltage 24
Transition Period in Machinery, The 208
Transmission of Power by Frictional Gearing 222
Transmission Rope Dressing. H. Jonson 605
Transportation in New York, Proposed Five Levels of. 88
Traveling Jib Crane and Traveling Jib Drill 625
Triangle for Isometric Drawing. Robert Grimshaw ... 386
Triple Vapor Engine 140
Triple Worm was Cut, How a. R. B. Casey 220
True Universal Chuck Jaws, To. J. E. Manierre 214
T-Slot Cutters, Making. J. Lord 323
Tube Cleaners, Destructive Action of Internal 315
Tunnel, Another Alpine 637
Tunnel, New East Boston ... 369
Tunnel System of Chicago .. 637
Turbine and its Manufacture, De Laval Steam 123
Turbine, An Experimental Gas. Dr. Alfred Gradenwitz 169
Turbine Blades, Wear of 619
Turbine Co., The De Laval Steam 61
Turbine Engine, First Large War Vessel to be Equipped With 460
Turbines, Impulse and Reaction 346
Turbine, The Crucial Test of the 532
Turning Cranks, Lathe for. G. L. F. 141
Turning Shaft Longer than Center Distance of Lathe. C. H. A. 105
Turning Steam Roll Necks, Device for. Otis D. Storer 438
Turning Tapers, On. (H. & W. 12) 161
Turning Trolley Wheels, Lathe Attachment for. J. R. Gordon 47
Turret Lathe, Bullard 36 inch Vertical 367
Turret Parting Tool. A. C. Neil 441
Turret Tool Holder. L. S. Rosenthal 159
Twist Drills, Proportions of. H. D. 646
Typewriter, Adding Attachment for the 371
Typewriting Machine, Newly-invented German 585

Uncle Josh:
An Expansion Chuck for the Vertical Mill 380
Under Cutting Tool, Feed Relief for Planer. H. D. Elliott 654
Underground, The London .. 366
"Unor"—a New High Speed Steel 638
Use and Value of Nickel Steel 290
Use of Electricity for Heavy Railway Operations 533
Use of Forced Draft instead of Induced Draft 533
Uses of High Speed Steel. G. H. B. 420
Utilizing Niagara's Power at Night 553

Vacation and What Came of It. A. A. P. Press 45
Vacuum System of Cleaning. 53
Valentine, A. L.:
Cutting English Threads with Metric Leadscrew. 440
Formula for Planing Thread Tools 489
Value of a "Run of Stone." (H. & W. 9) 107
Value of Photography 136
Valve, "Center Pressure" Stop 434
Valve Disk Design to Prevent cutting 497
Valves Operated by Electric Motor 68
Vanadium used in Electric Glow Lamp 603
Van Orman, W.:
Combination Forming Die 438
Punch and Die for Making Number Plates 50
Compound Punch and Die for Steel Range Work .. 271
To Prevent Spring Dies Closing in 105
Variable Speed Mechanisms 1 458
(2) Cone Disk and Sphere Devices 508
(3) Cone and Disk Devices 561
(4) Expanding Pulleys ... 616
Variable Speed Motors 584
Variable Speed Motors. William Baxter, Jr.:
(6) The C. & C. Electric Company's Series Parallel System 26
(7) Commercial Electric Co's System 120
(8) The Stow Multi-Speed Motors 171
(9) The Cutler-Hammer Variable Speed Controllers 246
(10) The H. Ward Leonard Controllers 348
(11) The Thomson-Ryan Variable Speed Motor .. 399
(12) The Electro-Dynamic Co's Inter-Pole Variable Speed Motor 513
Varnish for Cast Iron Patterns. J. A. Pratt 605
Varnish for Steel. J. M. Stabel 605
V-blocks for Planing Keyways in Shafts 433
Ventilating Blower with Motor 55
Ventilation, Amount of Air Required for 619
Ventilator of the Albespeyre Tunnel, The. Dr. Alfred Gradenwitz 32
Vertical Boilers in Power Plants 199
Vertical Mill, An Expansion Chuck for the, Uncle Josh 380
Vertical Milling Machine, Improvised. Charles E. Burns 323
Vibration in Steamships, Method of Preventing 538
Villars, J. D.:
Formula for Differential Indexing 154
Voris, Oliver E.:
To Prepare Iron or Brass for Laying out Work ... 444
To Soften Hard Cast Iron for Drilling 605
Vose, James:
Some English Lathes 21

Wages in the Krupp Works .. 86
Walter Kimball, of Richmond, Va. 264
Ward, Wilfred P., Richmond, Ind. Account of Grandfather's Old Shop 421
Warner Auto-Meter, The ... 362
Warner, E. E.:
Small Motors and Dynamos 438
War-vessel, New British 638
Washers and Specialties, A Punch for the Manufacture of 470
"Washington, Geo.":
Improvised Drawing Table 437
Water Connection for Car Wheel Press, Handy. A. E. Mitchell 443
Water from Freezing or Souring, To Keep. W. T. Sears 444
Water Hammer in Steam Pipes 37
Water Supply from Ice Cap in Peru 639
Water Pressure Maintained by Compressed Air 171
Waterproof Glued Joints, To W. S. Leonard 495
Water Space Watertube Boiler, Large 263
Water-tube Boilers for German Cruisers. G. L. F. .. 479
Water Turbines, Bouvier Governor for. Dr. Alfred Gradenwitz 523
Wattmeter Can be Made to Creep, How (H. & W. 53) 606
Wear of Shaper Tools, Device for preventing. A. R Chern 98
Wear of Turbine Blades 619
Webster, J. A.:
Carriage Stop for Lathe .. 383
Estimating the Cost of Machine Work 569
Weight Needed on Lever of a Power Hoist (H. & W. 26) 278
Weight of a Crowd of People 424
Weinland, R. Earl:
Soldering Aluminum 494
An Advertising Scheme ... 547
Welding, Gold 107
Welding Locomotive Frames, Thermit 645
Weller, B. M.:
Facing Bar Holder 269
Werner, Paul R.:
Punching Die for Making Labels 269
Westinghouse Compound Air Pump 640
What Is the Cause of this Trouble? W. K. 95
Wheels, Rolled Steel Car .. 427
Wheel, Steel-tired 477
Whipple, F. H.:
Radius Lathe Tool 437
Whitewash, Grant's Receipt for. W. E. G. 391
Whitney, Monument to Eli .. 84
Whittlesey, F. E.:
Non-Rusting Soldering Fluid 444
Williams, R. L.:
Tables Showing the Successive Events in Three and Four Cylinder Gas Engines 435
Willis, Warren E.:
Simple Safety Device for Set-screws 442
A Sketching Camera 326
Winding Springs. Herman Jonson 221
Wireless Ship Localizer, De Forest 290
Wire Rope, Making 202
Wire Ropes, Bending Stresses in 426
Wire Straightener. H. J. Bachmann 151
Wire Straightener. E. B. Kingsley 220
Woodbury, S. E.:
The Slide Rule, Position of the Decimal Point 189
Wood, H. E.:
Calipering the Fit of a Screw Thread 275
Practical Don'ts for Machinists 530
Wood Pavement in Hull, England 311
Wood Preservation 130
Wood-working Machinery, Speed in 33
Woodworth, Joseph V.:
Punching Small Holes in Tool Steel Blanks 419
A Novel Drill Press Attachment 490
Gang Milling of Repetition Castings 582
Wopaletzky, Eugene:
Planing a Cross Groove .. 161
Screw Cutting Kink 159
Working of Sulphur Deposits at Calcasieu Parish, La. .. 477
Works of the Ingersoll-Sergeant Drill Co., New 461
Worm Gearing, An Example of. Oscar E. Perrigo 525
Worthington Pumping Engine, A 90
Write Black on Glass or Bright Metal, To. F. H. Jackson 444

Y. M. C. A., Mechanical Courses at 137

Zambesi River Bridge, The .. 144
Zapote Tree 634
Zinc Black, Compound for Coating (H. & W. A to 16) 278

MACHINERY.

September, 1904.

A REVIEW OF STEAM TURBINE PATENTS.—1.

Up to 1904 there were over 300 steam turbine patents taken out in the United States and over 100 in England. These patents, in connection with the many that have been issued by the governments of France, Germany, Belgium and other countries, show that a great many inventors have directed their attention to the development of the steam turbine, and we also know that their efforts began at a very early date.

In fact, it is said that the first steam engine was a turbine. In Hero's "Spiritalia," a book on pneumatics issued in the second or third century, is a description of the whirling eolipile consisting of a small hollow sphere mounted on trunnions, one of which is hollow for the admission of steam. The sphere is caused to rotate by the reaction of steam flowing from two diametrically opposite nozzles having bent mouth pieces. This is frequently spoken of as the beginning of the reaction turbine; and to Branca, who issued a work entitled "The Machine," published at Rome in 1629, is given credit for the first impulse wheel. This volume contains an illustration of an eolipile, in the form of a negro's head, placed over a fire. A blast of steam proceeds from the mouth and impinges against the blades of a large wheel which it was proposed to connect by means of cog wheels with a crude stamping mill for pulverizing drugs. These very early efforts could have been nothing more than visionary schemes, but they are scarcely less impracticable than many of the later inventions to be found in the pages of the patent records. Comparatively few of the steam turbine inventions embody even the first elements of success, probably because most of those who have directed their attention to the subject have failed to understand either what was required or what means must be taken to accomplish good results.

When steam flows through a nozzle from a high to a low pressure, it issues with a velocity so enormous that it is difficult to comprehend its magnitude. The new Springfield rifle adopted by the United States Army gives an initial velocity to its bullet of 2,300 feet per second, or over 26 miles a minute. This is almost exactly the velocity with which steam of 50 pounds gage pressure would issue from a nozzle of the best shape when discharging into the atmosphere. With pressures of 100 or more pounds the velocity of the steam would be between 3,000 and 4,000 feet per second or at a speed of 35 or 40 miles per minute. The problem of converting this velocity into the rotary motion of a turbine wheel is not an easy one to solve, since the wheel must not only run with reasonable quietness and without danger of bursting, or of heating its bearings, but its speed must also be moderate enough to enable the power of the machine to be utilized in doing useful work.

In the successful turbine three main objects must be attained: 1st, as much of the potential energy of the steam as possible should be converted into kinetic energy, or the energy of motion; 2d, the wheel should be capable of utilizing the energy of the steam in an efficient manner; and 3d, the apparatus must run at a moderate speed at the point where it delivers its power.

To accomplish these results the best attainable workmanship and material are required, and this is one reason why the steam turbine has not proved successful until recent years. It is only recently that the quality of materials and workmanship have been such as to make the turbine possible.

In selecting from among the great number of turbine patents those that appear to have useful features we have had in mind the requirements stated above, and have not selected inventions unless they seem to embody at least one feature that would contribute toward a practical and operative machine.

Real and Pichon, 1827.

This machine operates by impulse and is one of the earliest attempts to produce a wheel to run at moderate speed and at the same time utilize a large percentage of the energy of the steam by the principle of compounding. Certain of the details of the original patent drawing are somewhat obscure, but in preparing the illustration, it has been made to correspond with the text as nearly as possible. The cylinder *A* contains a succession of disks, *B*, which divide the cylinder into compartments. The shaft *F* is turned with a series of steps,

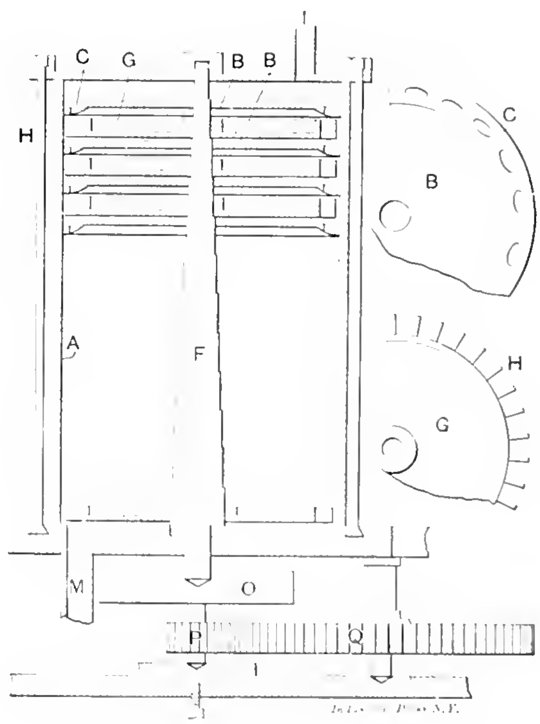

Fig. 1 Real and Pichon Compound Turbine.

upon each of which is carried a turbine wheel *G*, having short radial blades, *H*, around its periphery. Steam is admitted from the boiler through the pipe *I* at the top into the first compartment and flows in the form of jets through a series of openings, *C*, against the blades of the first wheel which runs in the second compartment. The steam next passes through a second series of holes in the second disk and impinges against the second wheel and so on to the bottom of the cylinder, where the steam exhausts through the pipe *M*. The shaft and wheels are carried by a step bearing and power is supposed to be transmitted through the gears *P* and *Q*. The openings, *C*, in the circumference of the disks, *B*, are bored obliquely, so the steam will impinge as directly as possible against the faces of the blades. With this plan the pressure will drop only a few pounds from chamber to chamber, giving the steam a comparatively low velocity of flow. This is substantially the plan used in the Rateau turbine except that in the latter the blades of the wheels are curved, so that the steam acts more efficiently.

In writing this review we have drawn on the historical material in the valuable series "Roues et Turbines a Vapeur," by Sosnowski, published in the August, September, October and November, 1896, numbers of the "Bulletin de la Société d'Encouragement pour l'Industrie Nationale," Paris. We have also been materially assisted by the list of English turbine patents in Neilson's treatise, "The Steam Turbine;" and by information kindly supplied by Mr. Robert A. McKee, mechanical engineer steam turbine department, Allis-Chalmers Co., and by the firm of H. Bollinckx, Bruxelles, Belgium.

Avery Turbine, 1831.

The first steam turbine patent to be issued in the United States was to Foster & Avery for a reaction wheel of the Hero type. Strangely enough, this is one of the few turbine inventions that has been developed and put into actual use, and probably it is the only steam turbine used in commercial work in this country until a considerably later date. There were several of these machines in operation in 1835, at least one of which was used to drive a saw mill at Syracuse, N. Y. In 1901 Prof. John E. Sweet contributed a description to the Transactions of the American Society of Mechanical Engineers, accompanying it by a sketch made from an original drawing of the Avery wheel, reproduced in Fig. 2.

The arm is made, with the exception of the end pieces and knife blades, of two pieces of iron brazed together from end to end at the edges. The openings at the ends of the arms for the steam jets were 1/8 by 1/4 inch. The speed of the tips of the arms was, of course, enormous. Mr. Avery states in his notebook that the speed of the arms of a 7-foot wheel placed upon a locomotive in 1836, which was put upon a railroad near Newark, N. J., and ended its life in a ditch, was

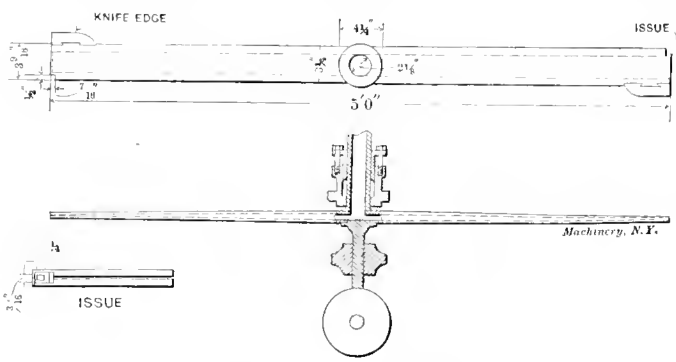

Fig. 2. Avery Reaction Wheel.

at one time 14½ miles a minute at the periphery. A difficulty met with was the end pressure on the hollow shaft, which was overcome by running the end of the shaft against the edge of a wheel set at right angles. The trouble in setting up the packing around the hollow shaft became a serious matter. It was also found that the knife edges at the end of each arm were cut away by the steam and required frequent renewal. The noise also was very objectionable. The economy was about the same as that of the common slide valve engine of that date.

Pelletan, 1838.

This invention is worthy of attention because it is an early attempt to utilize steam mixed with some other gas of greater specific gravity in order to reduce the velocity of flow of the steam and so permit a slower rotation of the turbine wheel. The Pelletan turbine is of the impulse inward-flow type. Steam enters through a valve similar to an injector, so arranged that the steam jet draws in the other gas and combines with it in the nozzle, which directs the jet against the vanes of the wheel. There have been many subsequent attempts to utilize this principle, both by the combination of some other gas with steam, and the combination of some liquid with steam; but none have been successful.

Leroy, 1838.

In commenting on Avery's invention Prof. John E. Sweet said that he had long had the conviction (previous to De Laval's invention) that expanding nozzles applied to the Avery turbine in place of the plain orifices used, would give the benefit of expansion and produce superior results. This would be the case were it not that the speed of a reaction wheel, at best extremely high, would be quickened by using nozzles that would increase the velocity of the escaping steam.

Leroy is perhaps the first on record with this idea of the application of the expanding nozzle. He was a prolific inventor and had definite notions about many features now employed in turbines. Figs. 3, 4 and 5 show three styles of rotating arms that he proposed to use for reaction wheels. The nozzle at N is clearly a diverging nozzle, as are also the orifices in Fig. 5. It is uncertain, however, whether he fully understood the principle of the diverging nozzle, because he states in one place that a nozzle in the form of a tube, Fig. 4, will produce a higher steam velocity than a funnel-shaped opening. While this might be true if the funnel flared too much, as seems to be the case, it goes to show that he did not understand the diverging nozzle at all.

Leroy was one of the first to propose a compound turbine. He shows two illustrations of machines—one a reaction and

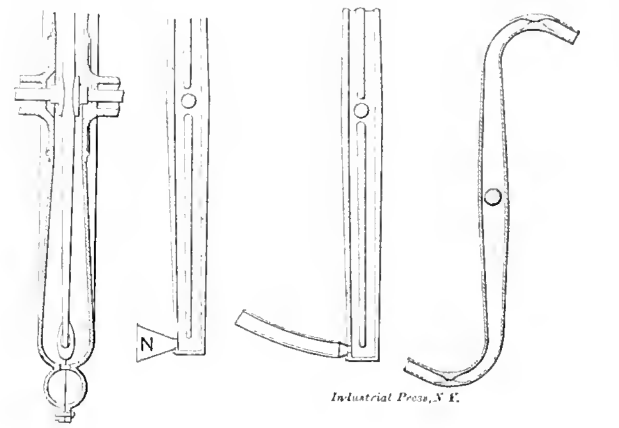

Fig. 3. Fig. 4. Fig. 5.
Le Roy's Reaction Wheels

one an impulse turbine, in which each wheel is encased in a separate chamber. In the reaction turbine steam enters the hollow arms of the first wheel through a trunnion at the center and escapes through openings in the periphery into the first chamber. It is then conducted by a pipe to the second wheel in a similar manner, where it finally escapes into the second chamber, and so on. His compound impulse turbine is entirely similar in principle to the Real and Pichon turbine except that instead of a succession of openings for the steam around the periphery the steam is conducted to each wheel by a single pipe. His drawings of the compound turbine are unpractical, because he makes no provision for the increasing volume of the steam as it expands. The drawings show passages of the same area near the exhaust end of the turbine as at the inlet end.

Pilbrow, 1842.

The inventions of Pilbrow were numerous. He experimented on the flow of steam and determined that for economical results the peripheral velocity of the wheel must be very high, and accordingly devised various arrangements for com-

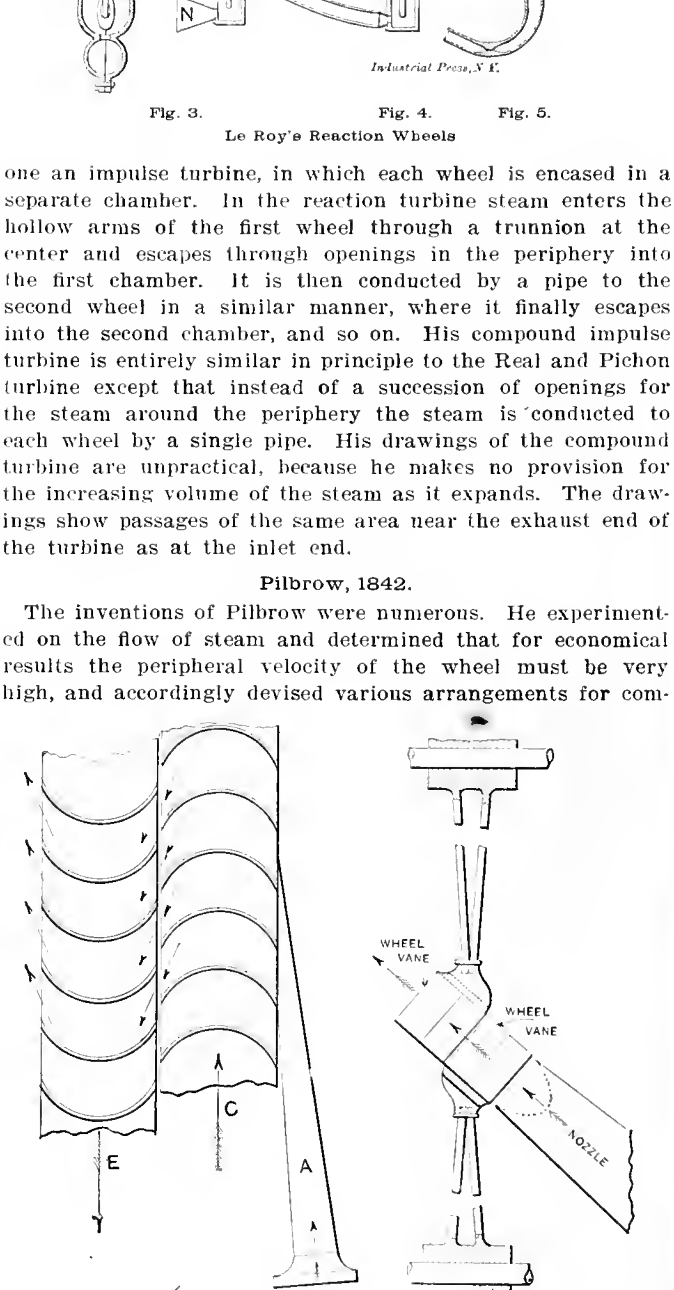

Fig. 6. Fig. 7.
Pilbrow's: Wheels Rotate in Opposite Directions.

pounding with a view to reducing the velocity to a practical rate. In all his compound turbines, however, he adopted the plan of running two or more wheels in opposite directions without stationary guide vanes, as shown in Fig. 6. Here steam enters through the nozzle, A, impinging against the blades of wheel C, which rotates in the direction of the arrow.

The steam then passes through this wheel and discharges against the blades of a second wheel, *E*, rotating in the opposite direction. Fig. 8 shows how he proposed to carry the idea still further by using several wheels, the alternate wheels rotating in opposite directions. Still another construction that he proposed is indicated in Fig. 7, where the two wheels rotate on parallel shafts, as shown, and have inclined vanes so located that steam from the nozzle will flow through the vanes of both wheels in the direction of the arrows. The buckets are curved, as in Fig. 6, and the wheels, of course,

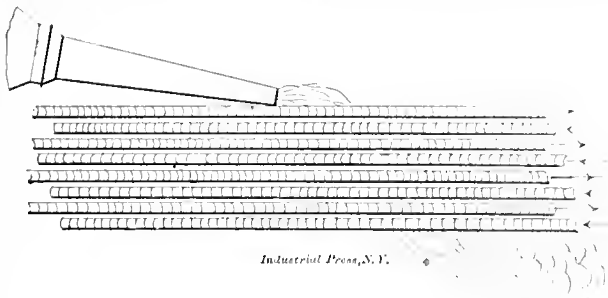

Fig. 8. Pilbrow's Multi-wheel Turbine.

rotate in opposite directions. Another modification of the design shown in Fig. 7 consisted in having several parallel rows of vanes for each wheel, which interlock with those of its mating wheel on the plan of a dovetail. With this construction the steam flowed through the vanes in a direction parallel with the axes of the two wheels. He proposed to couple the two wheels with a parallel rod, so they would keep together.

Pilbrow also proposed a reversing turbine consisting of two wheels inclosed in a casing, and two nozzles, one for each wheel. The nozzles pointed in opposite directions and the wheels would rotate in either direction, according to which nozzle was used.

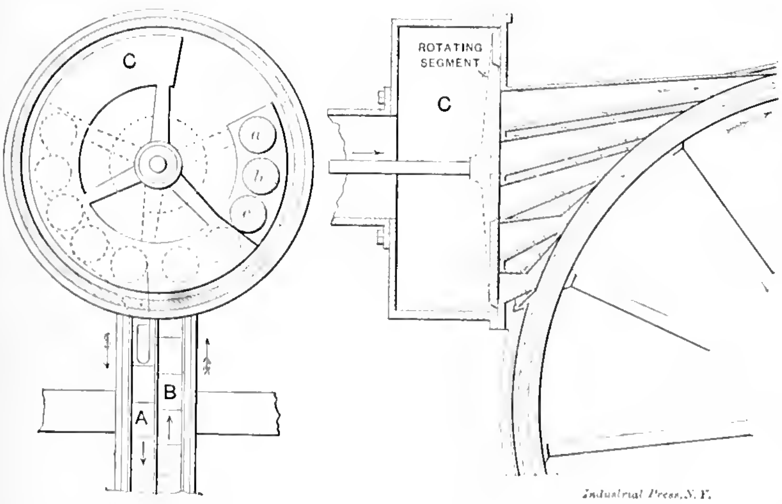

Fig. 9 Pilbrow's Reversing with Valve for Controlling Nozzles

Another interesting invention of Pilbrow is illustrated in Fig. 9. This is a reversing turbine arranged with a number of nozzles that can be shut off or opened successively by means of a rotary valve. The plan of using several nozzles which are brought into or out of action by valves, as used in the De Laval and Curtis turbines, probably here has its introduction, and the invention is of value on this account. Steam enters the chamber, *C*, in which is located a rotating segment that covers or uncovers the nozzle openings, *a*, *b*, *c*, etc. At *A* is the wheel with vanes pointing in one direction and at *B* one with vanes in the opposite direction. Half the nozzles connecting with chamber *C* direct the flow of steam against wheel *A* and the other half against wheel *B*. By rotating the segment, steam can be admitted to either wheel, causing the turbine to revolve in either direction, as desired; and also the amount of steam admitted can be adapted to the power required. A rotating valve of this description is not to be advocated as a durable construction.

Von Rathen, 1847.

Tho specifications of the patent of von Rathen are noteworthy only in that expansion cones or nozzles are a feature. His turbine is of the reaction type, no different in principle from Leroy's; and like Leroy's, the nozzles are not proportioned at all correctly for good results. He shows sketches of several different shapes of nozzles, some with conical and some with curved walls. He also designed a turbine to rotate in either direction by using a double set of nozzles pointing in opposite directions, with arrangements for conveying the steam through either set, as desired. In the reaction wheel

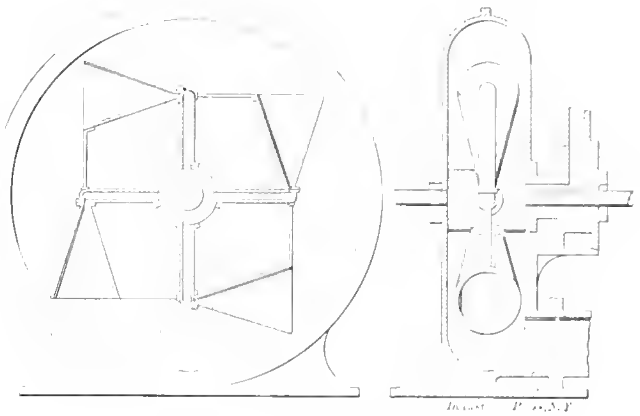

Fig. 10 Von Rathen Reaction Wheel

shown in Fig. 10 steam enters on one side at the center, flows outward through the radial arms and then discharges through the conical mouthpieces.

Wilson, 1848.

The inventions of Wilson rank among the two or three most important early steam turbine patents. His designs are the forerunners of the present Parsons type. He devised several compound reaction turbines in which the steam flowed through alternating sets of stationary and rotating rings of blades, expanding gradually during its passage through the apparatus. Fig. 11 is a sketch of his most valuable invention. Steam enters at the left, passes through the turbine in a longitudinal direction and exhausts at the outlet at the right. The vanes, *a*, *b*, and *c*, are attached to the drum, *D*, and rotate with it, while *d*, *e* and *f* are stationary guide vanes. The depth of the vanes increases from inlet to outlet, allowing for gradual expansion of the steam. This is really the Parsons turbine reduced to its simplest elements.

Another type—the radial flow wheel—is shown in Fig. 12. Here there are alternating stationary and moving vanes, and the steam flows outwardly through them, at the same time expanding to a lower pressure.

In Fig. 13 is still another type in which there is a single rotating ring of blades marked *B*. The steam is expanded and utilized upon this one ring of blades several times in succession by following a tortuous course back and forth through this ring *B*. Steam enters at *A*, passes through the moving blades to the chamber *C*, then returns through the guide vanes in this chamber to the chamber *D*; again it passes through the guide vanes to the wheel and into chamber *E*,

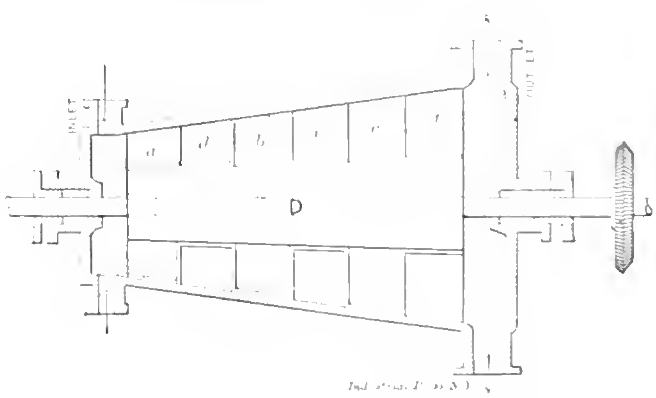

Fig 11 Wilson's Compound Turbine

then to chamber *F*, and so on. These successive chambers increase in size to allow for the increase in the volume of the steam as it progresses through the wheel, until finally it has

passed around the whole circumference and exhausts at the outlet *G*. This plan of allowing steam to act at different points in succession on a single rotating ring of blades, has since been worked out in various other ways, as subsequent patent specifications show.

Delonchant, 1853.

The speed reduction problem was attacked by Delonchant in the same way that it was later by De Laval; that is, instead of compounding he proposed to allow his turbine to run at

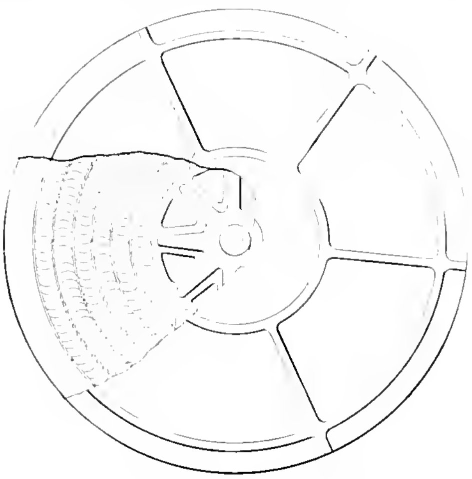

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Fig. 12. Wilson's Compound Radial-flow Turbine.

high speed and then used reduction gearing, in the form of the familiar "grindstone bearing." The arbor, *B*, of the wheel, Fig. 14, was supported on the circumference of anti-friction wheels, *C*. In explanation he says: "By the employment of these wheels instead of ordinary bearings, not only the rubbing of the first axes will be replaced by rolling friction but power will also be transmitted to the following parts, without gearing." In the illustration *A* is the rotating wheel; *B*, the arbor and at the center is a steam chest, *D D*, indi-

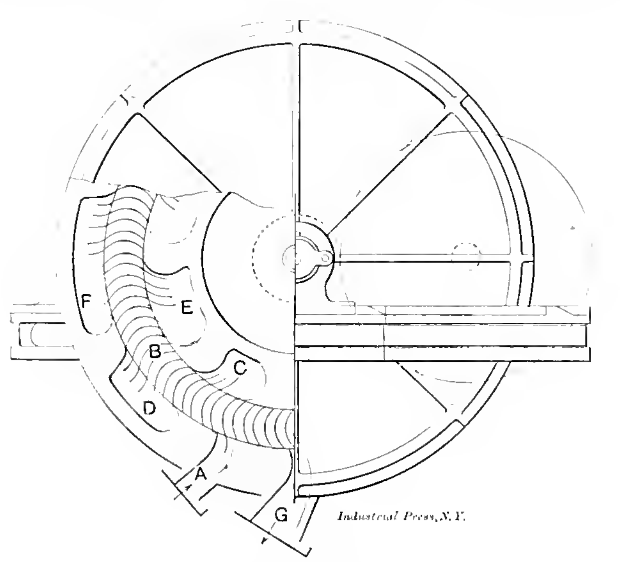

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Fig. 13 Another Type of Wilson Turbine.

cated in outline only. Steam passes from the steam chest through the passages *d d d*; and *E* is a ring having passages *e e e*, used in regulating the amount of steam flowing through the wheel. The passages, *d d d*, are so disposed that by rotating ring *E* the passage *e e e* through the ring will be successively cut off from the steam supply, or else opened to the supply. By moving 1-12 of a turn one passage is closed; another one-twelfth closes a second passage, and so on.

Tournaire, 1853.

In this year Tournaire presented to the Academie des Sciences a paper discussing the merits of compound turbines both of the impulse and reaction types. There is a copious extract from this paper in the Bulletin de la Societe d'Encouragement pour l'Industrie Nationale for September, 1896, and the facts explained by him as essential to a successful turbine are so in accordance with modern practice as to place him among the leading inventors. He says: "To overcome the difficulties of high velocities the vapor or gas should be made to lose its pressure in a continuous and gradual manner, or by successive fractions, by causing it to react several times upon the floats of turbines conveniently situated. Since the differences of pressure are considerable it is not difficult to recognize the necessity for a large number of successive turbines in order to sufficiently annul the velocity of the fluid jet. In spite of the multiplicity of parts the device must be simple in its action and susceptible of great exactness in construction." Tournaire believed he fulfilled these condi-

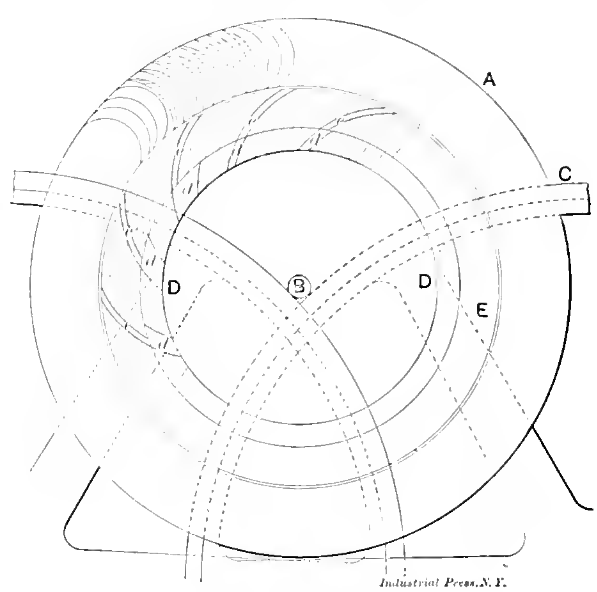

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Fig. 14. Delonchant.

tions by means of a machine composed of several wheels, shafts rotating on the same axis and driving the wheel which was to transmit the motion, by means of pinions. A plan of the buckets and vanes is given in Fig. 15, where *G G G* are the rotating elements and *V V V* the stationary elements. He describes the construction of the turbine in detail, but these structural features are of little interest at the present time. It is to be noted, however, that he appreciated fully the necessity for expansion. He says: "As the vapor will expand in proportion as it passes from the wheel buckets and directing rings, it is necessary that the passages between them become larger and larger." He also suggests losses from leakage, saying: "A part of the fluid escaping between the spaces which it is necessary to leave between the fixed and movable parts, will exert no action upon the turbine, nor will it be guided by the directing buckets. Shocks and eddies will be produced at the entrance and exits of the buckets." Again, "The friction which the narrowness of the channel will render considerable will absorb an appreciable part of the theoretical work." As to the structural features he suggests among other things, that "the cogs of the pinions which will turn with great rapidity, should work very evenly without shocks and jolts," and proposes the use of helicoidal gears. His turbine, as well as some of the others already described, is a vertical turbine rotating on a vertical axis.

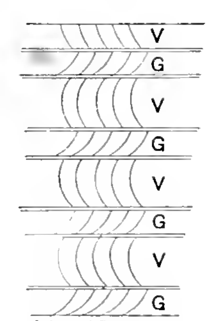

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Fig. 15. Plan of Vanes in Tournaire's Turbine.

Girard, 1855.

Three years later a turbine was patented having features that are of very doubtful utility but nevertheless of interest. Steam enters pipe *C*, Fig. 16, and flows upward through the curved annular passage, *D D*, where it enters the rotating wheel near the center. Girard in his invention endeavored to do away entirely with the stationary guide vanes and so eliminate the friction of steam against them. Accordingly the steam, starting at the center of the wheel, flows upward in a radial direction and impinges against curved rotary vanes at *a*. These vanes increase in width, allowing the steam

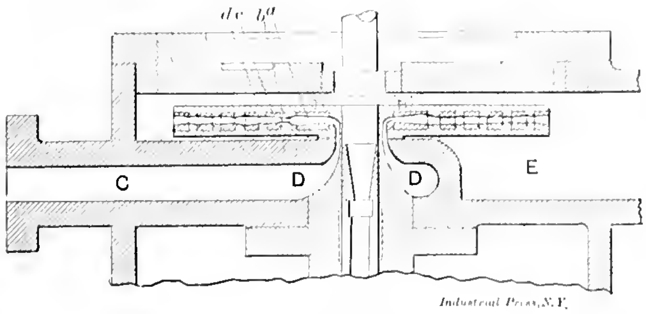


Fig. 16. Girard Turbine.

to expand somewhat until it enters an annular chamber, *b*, which is a part of the rotating wheel but which contains no vanes. The supposition is that steam will come to rest in this chamber, then flow radially outward again through guide vanes at *c*, coming to rest at *d*. The error in this arrangement is evidently in supposing that the steam will come to rest. Instead the steam would flow continuously through the various passages and the wheel would not absorb any more energy than if simply discharged through orifices on the circumference, as in a Barker's mill. This patent is mentioned because it is possible for a radial outward-flow wheel to be constructed without guide vanes, the steam entering the moving passages in radial directions; but the wheel would be quite inefficient.

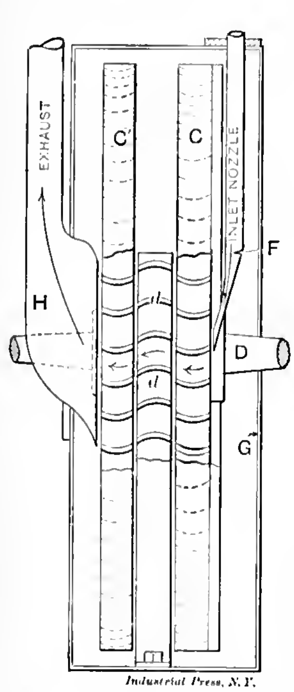


Fig. 17. Hartman's Compound Impulse Turbine.

John and Ezra Hartman, 1858.

Standing in importance with the inventions of Wilson and Tournaire are the English and American patents of the Hartman brothers, from the drawings of which Fig. 17 is made. The patent relates to a "mode of obtaining motive power by causing steam or air to impinge upon a series of chambers with curved bottoms ranged around a wheel at or near the periphery thereof; and second, the general construction and arrangement of machinery or apparatus for obtaining motive power." Fig. 17 shows the most important modification of the patent, of which

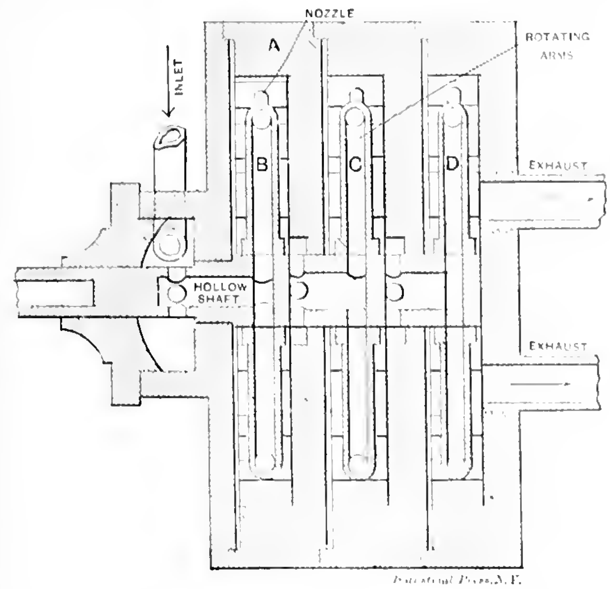


Fig. 18 Monson's Compound Reaction Wheel.

the following is the inventor's description: "This represents a detail of the third modification wherein we propose to employ two wheels, *C C'*, both wheels being fast on one shaft, *D*. A space is left between the contiguous faces of these wheels for the reception of four or more returning chambers, *d d*, the bottoms of which are curved in a direction opposite to that of the bottoms of the chambers in the wheels. These chambers in other respects are precisely similar to those in the wheels and are fitted to a rim which is bolted or otherwise secured to the interior of the casing, *G*. The jet pipe, *F*, is at one side of the wheel and the discharge pipe, *H*, on the opposite side of the second wheel.

The jet pipe on being first introduced impinges against the curved bottoms of the chambers in the wheel *C*, and is thence diverted against the fixed chambers, *d d*, whence it is again diverted on to the curved bottoms of the chambers in the second wheel, *C'*, and finally passes off by the escape pipe, *H*.

Charles Monson, 1862.

We have already illustrated types of simple reaction wheels but a search of the patent records shows that several inventors have attempted to improve on this arrangement and produce a turbine which will run at slower speed, by having a succession of simple reaction wheels, each one in separate chamber and arranged so that steam issuing from a wheel into its chamber will then pass through to the next wheel, and so on. This in substance is the design of Monson's turbine, shown in Fig. 18. The leading specification of his patent is as follows: "A repeating rotary engine constructed in a manner so as to operate substantially as described; namely, of two or more sets of curved arms, *B*, *C*, *D*, or their mechanical equivalents; a series of two or more tight chambers or passages, *A*, and a shaft or its equivalent divided into separate chambers and provided with induction and escape passages." The course followed by the steam will be evident from the engraving.

* * *

A PROCESS FOR COPYING PRINTED PICTURES.

JOSEPH C RILEY.

The so-called "metallic" paper used for steam-engine indicator cards is familiar to all mechanical engineers. It has a smooth surface, chemically prepared so that black lines can be drawn upon it with pencils made of brass, copper, silver, aluminum, or any of the softer metals. When used on the indicator, it receives the faint line drawn by a brass point at one end of the pencil arm, and its special advantage over ordinary paper is that the metallic pencil slides over its surface with very little friction, and keeps its point much longer than a graphite pencil.

Another property, not generally known, is possessed by this paper, and may possibly render it of great value for a purpose quite different from that for which it is now manufactured. It can be used as a transfer paper for copying engravings or sketches, or in fact anything printed or written in ink or drawn in pencil. If a sheet of it is laid face downward upon a printed picture, and then rubbed hard upon the back with a blunt pointed instrument, such as the rounded end of a pocket-knife handle or a smooth piece of ivory, a copy of the original picture will be transferred to the indicator paper. The copy is produced by removal of ink from the print, but the amount removed, although enough to make fairly dark lines, is so small that the original is left practically uninjured and nearly as dark as before. Firm pressure of the tool is necessary, but pressure alone will not effect the transfer; abrasion of the ink surface is necessary, and it is secured by the very slight slipping of one sheet over the other, caused by local stretching of the paper under the point of the rubbing tool. Any more than minute, local slipping must of course be prevented, or a blurred copy will result. The transfer paper should be protected by a thin piece of cardboard laid over it, and the two should be held tightly under the thumb and forefinger of the left hand while the tool is rubbed all over the cardboard, from side to side and top to bottom. Less than a minute is sufficient time for transferring a cut from two to two-and-one-half inches square; larger ones require longer time and the exercise of care to prevent stretching and consequent distortion, the difficulties becoming so great that the process seems at present limited to pictures not over four inches square. A corner of the transfer paper may be turned up for examination at any time.

Line drawings printed from relief plates, or pictures with

sharp contrast of black and white without any half-tones, give the best copies. Very few half-tones can be transferred satisfactorily; almost all give streaked, indistinct copies and many of the results are worthless. This process is not recommended for copying half-tones.

The transfer taken off as described is a *reverse* of the original print, "a view of the opposite hand," as draftsmen say, and any lettering on it will read backward. If the question of right and left is not important, this reversal will seldom be objectionable, for it is easy to read backward what few letters generally occur. However, if desired, the paper may be held up to the light and examined from the back, or placed before a mirror and viewed by means of its reflected image, when the true relations of right and left will be seen. Moreover, if sufficiently important, an exact counterpart of the original may be taken from the reversed copy by laying another sheet face downward upon it and rubbing on the back of the fresh sheet just as was done in making the reversed copy. The impression thus produced will be fainter than the first, but almost always it can be made dark enough to show a distinct outline which may afterward be retouched with a lead pencil.

Fig. 1 shows a reversed copy transferred from a picture in a steam-engine catalogue. The original is in black ink on plate paper and measures 2¾ by 4 inches. It is reproduced in the columns of MACHINERY by printing from a half-tone plate, photographically prepared, and the lines do not appear so clear as in the original. However, the reader is assured that the copy in question is clear in detail and about half as dark as the original picture from which it was taken; and that, furthermore, not enough ink was removed from the original to cause any perceptible change in appearance.

Fig. 2 shows a reversed copy, and Fig. 4 the true copy made from it in the manner described. The second is but little fainter than the first, and both possess a certain artistic softness and quality of line not found even in the original.

Fig. 3. was transferred from a tracing made with Higgins' indelible drawing ink. The copy was made in about forty seconds, and is both dark and clear.

Fig. 5 and Fig. 6, which was produced from it, are transfers of handwriting in Carter's Koal Black ink which had been dry more than two months. This process offers a quick means of obtaining facsimiles of signatures without injuring the documents to which they are attached. It will doubtless be appreciated by collectors of historic autographs—perhaps also by persons of another, not strictly legitimate vocation.

For indicator cards, the paper is prepared by coating one surface with a suitable compound, usually zinc oxide mixed with a little starch and enough glue to make it adhere. After drying, it is passed between calender rolls under great pressure. The various brands manufactured for the trade, though perhaps equally good for indicator diagrams, are not equally well suited for copying. A paper supplied by the Crosby Steam Gage & Valve Co. was used for the cuts illustrating this article. Its surface appears to have just the quality required for transferring ink and preserving clear lines, but the body of the paper is a little softer than it should be, and, unless care is taken, it is likely to stretch when copies over two inches square are attempted. If paper of firmer texture could be prepared with the same surface finish, probably much larger copies could be produced.

Other kinds of paper, notably the heavy plate papers used for some of the best trade catalogues possess this transfer property to a slight degree, though they will not receive marks from a metallic pencil. The latter feature would seem to recommend them for transfer purposes, making them less likely to become soiled by contact with metallic objects, but so far no kind has been found which will remove enough ink to give copies anywhere near as dark as the indicator paper.

In choosing pictures for illustration, the writer selected those which could be copied with best results. Fairly good transfers can be made from almost any common printer's ink, but some inks copy much better than others, and some yield only the faintest impressions. The length of time since a picture was printed does not seem to determine its copying quality. Some very old prints can be copied better than new ones; in fact, it was by accidental transfer to an indicator card from a book nearly a hundred years old that the peculiar property of this "metallic" paper was discovered.

The reader has probably noticed in examining old books, that reversed impressions of engravings are often found on the fly leaves or tissue sheets which face them. This is probably due to chemical action between the ink and the paper; it is not the result of a physical transfer, for usually the ink was dry before the book was bound, and since that time it has not been subjected either to friction or to great pressure.

How many draftsmen and engineers have often wanted private copies, however faint or imperfect, of small details which were too complicated to remember, and which would require too long to trace; how often persons reading in any branch of science would like to make copies of pictures or diagrams from books which they cannot buy, or which are too cumbersome to have at hand when wanted. A ready means of supplying such demands with exact copies of the originals, however intricate, is afforded in this frictional transfer process. For small copies the results are already very satisfactory, and it is believed that by improvement the process can be made of value for work of a much more pretentious character.

Since the above was written, it has been found that much better copies can be made by following the directions below, instead of those already given. Lay the metallic transfer paper, *face up*, upon at least a dozen sheets of blank paper, and lay the print *face down* upon it. On the back of the print, place a sheet of heavy paper, or thin cardboard, and run the rubbing tool over this protecting sheet. In this manner it is comparatively easy to prevent slipping, and prints eight or ten inches on a side may be copied satisfactorily.

* * *

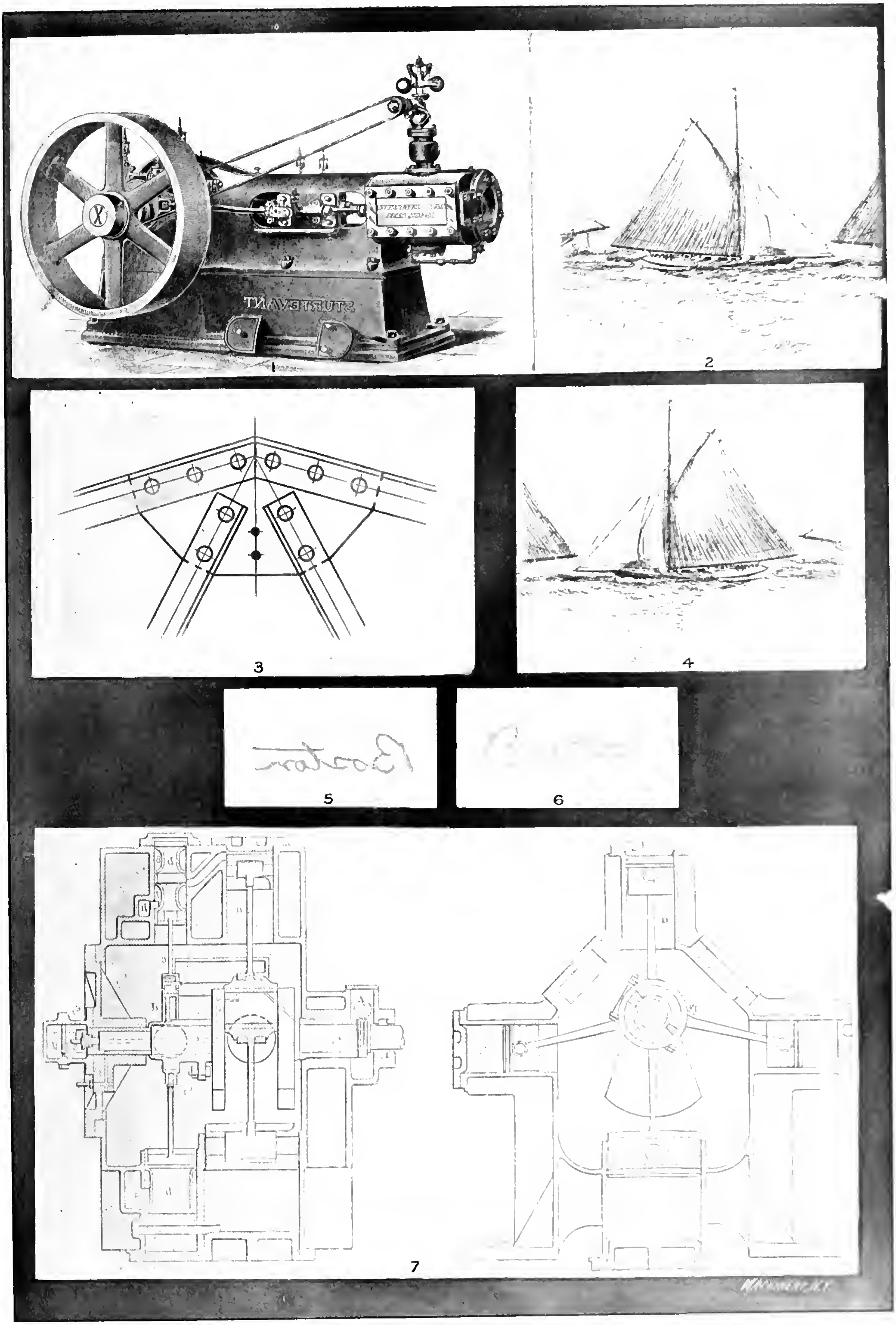
ESSEN AND THE KRUPP WORKS.*

In spite of its fame and its situation on one of the main highways of Europe, Essen is little known. "There is nothing to see except the works. In 1811, when the first smelting furnace for casting steel was set up by Peter Friedrich Krupp, the population of Essen was under 4,000. In 1901 it was 183,500, out of which the Krupp contingent numbered about 84,000. At the same date there were more workmen's dwellings built by the firm than there had been inhabitants when it was founded. Now, this and a great deal more is essentially the work of one man, and it is unparalleled in the history of industry. It must not be supposed, however, that the Krupp family created Essen out of the wilderness, as some places have been created by industrial enterprise. The place is ancient and has a history. In the Middle Ages it was a walled city; the shape of the central quarter, the narrow and winding streets, and the names of the four gates survive as reminders of the past, but no other vestiges remain. For centuries also Essen was famous for the manufacture of firearms. The command of running water and of coal, which is mentioned in connection with Essen as early as 1317, accounts for the development of these industries. They appear, however, to have declined gradually during the eighteenth century, when the town fell into a decayed condition. Modern Essen may be said to date from the evacuation of the French in 1813, which almost coincides with the original foundation of the Krupp works and marks the beginning of a new era.

The Krupp Family.

Peter Freidrich Krupp was born in 1787 and went as a youth into some iron works at Sterkrade, which came into the possession of his grandmother in 1800. These works had been started in 1780 and were among the earliest in the district; they still give their name to the large iron and steel business known as the Gutehoffnungshütte of Oberhausen. Here young Krupp worked at the invention of a process for casting steel and committed the reprehensible imprudence of marrying at 21. He went to Essen, where some iron works that had been built for the abbess in 1790 were at this time acquired by the firm, which also became the owners of the Sterkrade works. This connection may have been the reason of Krupp's settling in Essen, but at any rate he soon set up for himself, and at the age of 23 he purchased a small forge worked by water power, where he devoted his time to secret

*Abstract of article in Consular Report No. 2009, taken from the London Times.



Half-tone Reproduction of Impressions on Metallic Paper, taken from Printed Engravings. Reproduction Full Size. See "A Process for Copying Printed Pictures."

experiments in smelting steel in small crucibles. To this day the casting of crucible steel is the great specialty of the Essen works. A son, Alfred, was born to the young couple in 1812, when Friedrich Krupp was 25. Want of means compelled him to enter into partnership at this time, and in 1815 the firm announced that they were prepared to accept orders for cast steel; but as no orders came the partnership was dissolved and he was left to struggle on alone. This he did for some years, but with difficulty, until in 1826 he fell ill and died, leaving a widow and four children. Alfred, the eldest, was then 14, and on his shoulders fell the burden of carrying on the business. His father had intrusted the secret to him and taught him the trade. Alfred left school at once and took his place in the shop, where he worked at the furnace and the forge harder than his own handful of journeymen, and for years made no more than sufficed to pay their modest wages. "For my own toil and pains at such an early age," he said afterward, "I had no reward but the consciousness of doing my duty."

Few schoolboys have entered on the struggle for life with such a laborious inheritance and fewer have emerged so victoriously after so long a probation. For twenty-five years the fate of the concern hung in the balance, and success became assured only after the London Exhibition of 1851. Four years previously the first gun, a 3-pounder of cast steel, had been finished. Thenceforward the story is one of rapid and almost continual progress. In 1853 the manufacture of weldless steel tires was begun. Ten years later the first workman's colony was built, and not long after Herr Krupp found himself in a position to obtain command of raw materials, and so placed the business in a self-sufficing and impregnable position by the purchase of iron mines and blast furnaces, presently followed by coal mines. He died in 1887, having been for sixty years the head and for forty years the sole proprietor of the works, which then passed to his only son, the late Friedrich Alfred Krupp. They have been greatly extended since by the addition of other works and mines and, in 1902, the Germania shipbuilding yard at Kiel, but are still, with all their branches and appendages, the sole property of the family. They are managed by a board of directors. On April 1, 1902, the total number of persons employed at the various works was 43,083, representing, with their families, a population of about 150,000. The numbers were thus distributed:

Steel works at Essen	24,536
Gruson works at Buckau	2,773
Shipbuilding yard at Kiel	3,987
Coal mines	6,159
Blast furnaces, proving ground, etc.	5,628
Total	43,083

The old-fashioned little house of five rooms in which Alfred Krupp's parents lived and worked and brought up their children, hard by the original forge, still stands at the entrance to the works, and a tablet on the door refers, modestly enough, to the privations, efforts, and anxieties which attended the founding of the business and overshadowed its career for many years. The contrast between the small, struggling beginning and the immense eventual achievement stands embodied before one's eyes with a dramatic significance which cannot fail to impress; but if one inquires the origin of other manufacturing concerns one finds that with rare exceptions—and those of recent date—they were started in much the same manner, went through similar early struggles, and survived by virtue of the same qualities.

The Town

The English town which most naturally suggests itself for comparison with Essen is Sheffield; and there are many points of resemblance between them. Both lie on the same hilly sort of ground that goes with the presence of coal; both have narrow, old-fashioned, irregular streets; both have charming country on their outskirts, though in this the advantage lies with Sheffield; and both manufacture the same things on the same scale. On the other hand, Sheffield is more than twice as big, it is a much older manufacturing place, and has a greater variety of manufactures. The ancient cutlery industry, file cutting, and electroplating give it a special character which is lacking to Essen. Take them as they stand, however, for what the comparison may be worth, and it must be admitted that the German has rather the best of it. The site of the Krupp works on the lower side of Essen, in and out out of the town, is curiously like that of the great Sheffield works—at Cammell's, Brown's, Firth's, and Vickers and Maxim's—which lie all together in a similar position, and probably occupy even more ground between them. They certainly make more smoke, or it hangs more persistently about. Sheffield is the grimiest of all our manufacturing towns, with the possible exception of Gateshead, and a large part of it is generally wrapped in a pall which neither London nor Manchester can equal. America alone, with her genius for surpassing everything, easily beats it. Compared with the inferno of Pittsburg and the lesser, but still more grimy and squalid, hells up the Monongahela Valley—Homestead, Braddock, and the rest—Sheffield is clean and Essen a pleasure resort, in spite of the fifty or sixty tall Krupp chimneys that flank it on one side and various other factories, with sundry coalpits, on the other.

The Industries.

Apart from Krupp's the industries of Essen are not extensive. There is one considerable iron works which makes a specialty of boilers, a chemical factory, breweries, and several coalpits. The town lies over the coal bed and the mines run underneath it. The great Rhine-Westphalian Coal Syndicate —probably the most important industrial combination in Germany—has its headquarters at Essen. The products of the Krupp works are very varied. Their firm is chiefly associated with war material, but they minister no less to innumerable peaceful purposes. All kinds of finished and half-finished material for railways, ships, engines, tools, mills, and other industrial appliances are turned out in large and small quantities. The war department turns out guns of all sorts, of which 39,876 had been delivered up to the end of 1901, projectiles, fuses and ammunition, rifle barrels, and armor. The manufacture of offensive and defensive material is a lucrative game of see-saw, in which the governments of the world are pawns in the manufacturer's hands. It is like the burglar and the safe. The scientific possibilities are infinite, and the experts have only to turn their attention to each in turn and their customers must follow. A more powerful gun, a more vicious projectile, or a new ammunition, and the old defenses are obsolete. The governments hasten to provide themselves with the latest instruments of destruction. Then the metallurgical chemist brings a new hardening process or a new alloy on the scene and produces armor which defies the latest weapons; and again everybody must have it, or questions are asked in Parliament. Thus it happens that the Essener-Hof—that most exclusive of hotels, which stands hard by the works and is reserved for distinguished customers—never lacks guests from all parts of the world. They are the emissaries of their governments, watching the execution of orders. There is not much fear that any of the great powers will outstrip the rest to an alarming extent. These matters are, of course, profound trade secrets; but somehow or other Essen knows pretty well what is going on at Elswick and Sheffield, which return the compliment, and all three have made up their minds about the merits and defects of the new French gun before it has been delivered.

* * *

Many young draftsmen who are desirous of learning to letter drawings neatly, would undoubtedly appreciate, for practice, a stipple paper with rows of dots in slight relief. The upright rows should make an angle of 60 degrees to the horizontal, the tops, of course, being inclined to the right. The spacing of the rows of raised dots should be about 1-128 inch each way, the distance of 1-128 inch forming the unit for proportioning the letters. Thus if lettering in the familiar *Engineering News* style, the body of lower-case letters would be made, say, 8 spaces high and the total height would be 12 spaces in descriptive legends. The proper slant of the letters would be naturally formed by the pencil point following the inclined rows of dots, and horizontal lines in the same way. A few weeks practice on such paper would do much to cultivate the proper stroke and sense in proportion that is often sadly lacking with draftsmen when it comes to neat lettering

CHARTS IN DESIGNING.

JOHN S. MYERS.

John S. Myers.

Charts which are used for recording data or for assisting the designer in proportioning his work or in making calculations, may be classified, according to the purpose for which they are intended, under two general heads, *i. e.*, Record Charts and Calculating Charts.

To the first class belong cards from all recording devices and diagrams of any kind laid out from known values, such as graphical representations of results of tests. Such charts may constitute a record pure and simple; they may be for the purpose of better showing the existing relations of the quantities involved, for ascertaining mean, intermediate or proportional values, or they may be developed with a view to discovering losses, irregularities, errors, etc.

The following development of one of a series of tests on the power required to drive rivets is a fair illustration of the applicability of record charts:

Experiment* on ¾-inch rivets, holes punched 13-16 inch at top, about ⅞ inch at bottom, 1 8-20 inch grip, about 1½ inch projection of shank before driving. The rivets were driven on an Allen riveter, the frame having been previously calibrated as a spring balance by measuring the deflection in thousandths of an inch with a micrometer, for known loads suspended from the die. Chart No. 1 shows the calibration of the frame.

In chart No. 2 the full curved line represents graphically the results of experiment as tabulated. The dotted curve represents allowances for efficiency and inequalities in length of the rivet, plotted with a view to determining the energy required for a power driven machine. In this test the mean average pressure during period of driving was 40,925 pounds. The distance passed over under this mean pressure was 29-64 inch.

$$\frac{40{,}925 \times 29}{64 \times 12} = 1{,}545 \text{ ft. lbs. of energy.}$$

With allowances as per dotted line $= \dfrac{38{,}000 \times 1.25}{12} = 3{,}960$ ft. lbs. If exerted every 3 sec. the H. P. to drive alone $= \dfrac{3{,}960 \times 60}{33{,}000 \times 3} = 2.4$. Of course allowances would have to be made for other losses and for extra stroke.

The uses which have developed for charts have become as numerous as the different branches of industry with which they are associated. Their construction, when taken up in detail, is even more varied than their uses. Cold figures never convey to the mind as clear a conception of relative values as a graphical representation, and in the case of experiments the tabulated data often brings to view points when charted, which would not otherwise be noted.

Frequently a record chart is used to interpolate between known values, obtaining unknown ones, as was the calibration of the riveter frame in the foregoing example.

Similar to the last mentioned class of charts, but closely allied to Calculating Charts, belong stress diagrams and all kindred matter in the art of graphostatics so much used in the determination of stresses in framed structures, bending moments in beams, etc.

Calculating Charts may be defined as those which express mathematical relations of quantities. They are of two varieties: Those upon which certain mathematical operations may be performed according to any sequence, the quantities being either concrete or abstract and of any denomination and measure desired; and those designed for dealing only with concrete numbers of definite measure and denomination, the quantities involved having a fixed mathematical relation and sequence.

Under the first subdivision, if this liberty of classification be permissible, come all forms of calculating instruments, such as the slide rule, Sexton's omnimeter, Thatcher's calculating machine, etc. The principles upon which these operate are quite generally known, leaving little to be said in this connection. There is, however, a spirit of distrust regarding the accuracy of calculations performed upon a slide rule far too prevalent. Because one reads from the rule 975 pounds as the weight of a casting and the actual multiplications give 974.235 pounds, is that any reason why the rule should not be used for estimating weights? In all probability one would set the weight down as 980 pounds for sake of even figures, and if a casting it might come out of the sand weighing over 1,000 pounds.

In calculating stresses, for instance, who cares for a hundred pounds more or less? If the assumed fiber stress be 10,000 pounds per square inch, an error of even 500 pounds is only 5 per cent. The rule has a wide sphere of usefulness

TABLE 1

No. of Rivets.	Deflection of Frame.	Pressure at Die, pounds	Total Length of Rivet Head to Head	Height of Head being Formed.	Remarks.
1	.016	6000	3 [illegible]	[illegible]	End stove up.
2	.022	9600	2 [illegible]	[illegible]	End stove up ¼ more.
3	.036	15000	2 [illegible]	[illegible]	Head commencing to form in die
4	.063	26000	2 [illegible]	[illegible]	Head formed in part only.
5	.095	39000	2 [illegible]	[illegible]	Head not completely formed.
6	.150	62000	2 [illegible]	[illegible]	Fairly well formed head.
7	.208	82600	2 [illegible]	[illegible]	Better head, hole well filled.
8	.214	87800	2 [illegible]	[illegible]	Some hotter than last rivet; good head

and those persons who cry out so against it as an unreliable instrument are only lacking in judgment as to where and where not extreme accuracy is required.

The settings, Figs. 1 and 2, next page, illustrate the location of two much used constants which may be applied to any slide rule, and after used a short time their utility will become apparent.

Explanation: Set 4 on the B scale under π on the A scale; at left index make mark a on the C scale. See Fig. 1. Set second 4 under π and mark a_1.

Setting a or a_1 to any diameter on the D scale gives the area on the A scale opposite either index; setting runner to length on B gives volume on A.

Set the rule as above, Fig. 1, and the runner at 283 on the B scale as indicated at x; set the right index of the slide at this line xx and at left index make mark W, Fig. 2, on the C scale. Mark second W in line with the middle 1 of the A scale.

Setting either W to any diameter on the D scale gives the weight per inch of round steel bars on the A scale, setting runner to length on B gives weight of bar.

As an aid to the memory for the uses of these points, a stands for areas and W for weights.

Calculating Charts.

Taking up Calculating Charts in detail, simple mathematics may be divided into three elementary operations, each class consisting of a couplet in which the one member is the inverse of the other, viz.: addition and subtraction; multiplication and division; raising to a power or extracting a root.

Chart No. 3 illustrates how the operations of addition and subtraction may be performed graphically. Following the broken line in the direction indicated by the arrow heads represents operations as follows: $7 - 4 = 3$, $7 + 4 = 11$, $7 + 4 + 4 = 15$, $9 + 2 = 11$, $9 + 2 + 4 = 15$. Following these lines in the opposite direction would perform the inverse operation. It will be noticed that when the zero line is crossed to find the next value, addition is performed but when the zero line is not so crossed subtraction results, *i. e.*, the quantities represented by the diagonal lines on the same side

* The writer is indebted to Mr. A. L. Goddard, M. E. of the Edison Laboratories for the tabular data of this test.

of the zero line, as the quantity it is desired to combine with are negative.

Chart No. 4 illustrates in a similar manner the operations of multiplication and division. The arrows indicate the following: 6 ÷ 2 = 3, 6 × 2 = 12, 6 × 2 × 1.25 = 15. The line *A-A* represents multiplication by 2 combined with addition of a constant whose value is also 2, thus: 6 × 2 + 2 = 14. This line is drawn parallel to the multiplier (in this case 0-2) and has its point of origin at the constant. Line *B-B* represents division by 2 with addition of a constant 2, thus: 12 ÷ 2 + 2 = 8. It will be noticed that in addition and subtraction the parallel diagonal lines have their origin at the value they represent, and their terminus at a similar value on the side adjacent, if the scale on that side were reversed; while in multiplication and division the lines are divergent and have their origin at the common zero point of the two scales.

In Charts Nos. 3 and 4 the operations may be carried on continuously within the range of their readings, thus: [(9 + 2 = 11) + 4 = 15] — 2 = 13, and similarly in Chart No. 4 [(6 × 2 = 12) ÷ 1.5 = 8] × 1.25 = 10. This is dealing with abstract numbers, however. A single line chart handling concrete values will combine two quantities and give the result of whatever the operation may be. A chart having two sets of sloping lines will combine three values giving the result. If more than three values are to be combined, a multiple chart, as illustrated by Chart No. 5, may be used. The

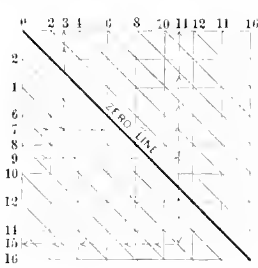


CHART NO. 3

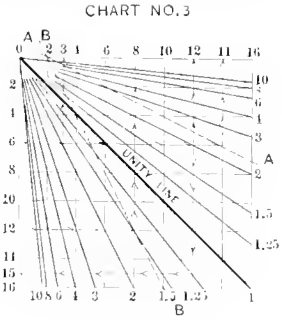


CHART NO. 4

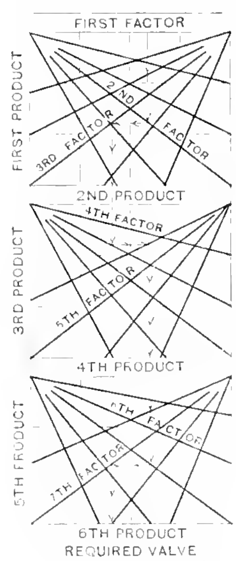


CHART NO. 5

Machinery, N.Y.

following is a concrete example of the last-mentioned chart, illustrating plain multiplication and division. (See Chart 6.)

Tank Chart.

Required: the thickness of tanks of various diameters and heights for containing different fluids. The formula for thin cylinders is as follows: $t = \frac{pd}{2sy}$, where t = thickness in inches, p = pressure in pounds per square inch, d = diameter

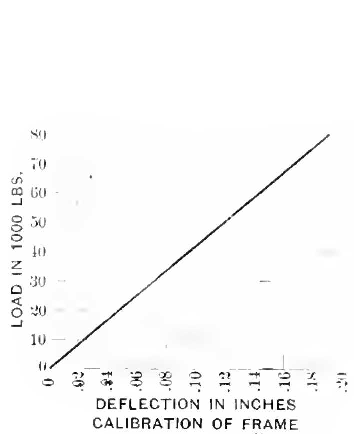


Chart No. 1.

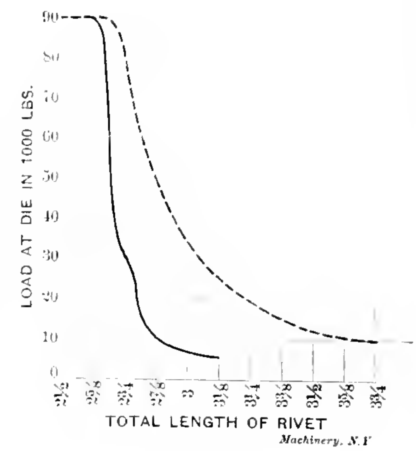


Chart No. 2.

in inches, s = allowable working stress in pounds per square inch and y = the efficiency of the riveted joint.

Let D = diameter in feet, H = head in feet, and G = specific gravity of fluid; then

$$\frac{.433\ H\ G\ 12\ D}{2\ s\ y} = 2.598\,\frac{H\ G\ D}{s\ y}$$

In operations of multiplication and division the order in which the factors are taken does not affect the value of the result; it is therefore advisable to choose those quantities which are most constant for any given problem as the first factors of the chart. In this case the order has been chosen as follows: diameter, specific gravity, stress, efficiency of joint and head.

Next in order of importance comes range of readings and scales. It is always desirable to make the range of a chart as great as is consistent with reasonable accuracy. In the case under consideration the range of diameters has been chosen between 6 and 120 feet, but in order to secure this range three different scales have been used; 2 feet per space from 6 feet up to and including 20 feet; 5 feet per space from 20 feet up to and including 60 feet; 10 feet per space from 60 feet up to and including 120 feet. (Chart No. 6.)

This change of scales necessitates three different points of origin for the lines representing the second factor, but the error of interpolation is thus kept within reasonable limits without making a chart of abnormal proportions.

To aid one in deciding upon appropriate scales and limits of readings for the other factors and products, it is well to tabulate these factors and their resulting products: first choosing assumed limits of readings for the intermediate

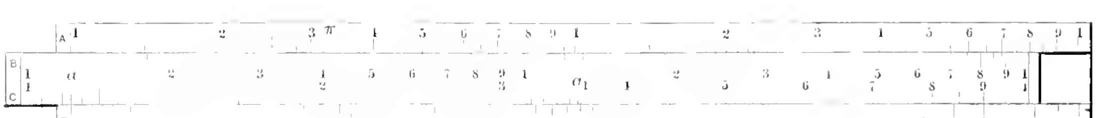


Fig. 1

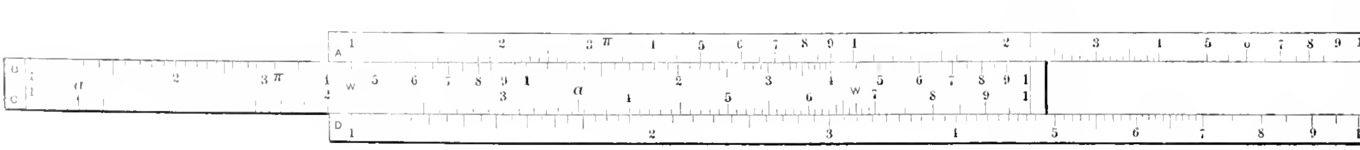


Fig. 2

quantities which will produce the minimum final value, then vice versa, and lastly, what may be considered a practical problem of maximum sizes. (Table No. 2.) From these values the range of the different products has been chosen, as indicated in the last two lines of the table. Their scale will be determined by the size of the sheet it is desired to use. Since it is not necessary to have the points of origin lie within the border lines, it is desirable to keep the minimum readings greater than zero when this can be done without impairing the utility of the chart.

The problem illustrated by the arrows in Chart No. 6 is a tank 85 feet in diameter, specific gravity = 1.0, 16,000 pounds fiber stress, 65 per cent. efficiency of joint, and 35 feet head.

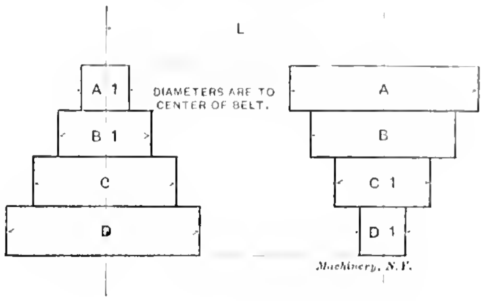


Fig. 3.

The thickness is read to the nearest even fraction on the side of safety as ¾ inch.

Cone Pulleys.

The following chart (No. 7) for cone pulleys illustrates the variable scale principle combined with subtraction and division. For crossed belts the belt will be of uniform tension when $A + A_1 = B + B_1 = C + C_1$, etc., but for open belts the middle steps must be larger in diameter than for crossed belts.

The formula used by the machine tool combine for this case is as follows: (See Fig. 3.)

$$x = \frac{(A - A_1)^2 - (B - B_1)^2}{2\,\pi\,L}, \quad x_1 = \frac{(A - A_1)^2 - (C - C_1)^2}{2\,\pi\,L},$$

$$x_2 = \frac{(A - A_1)^2 - (D - D_1)^2}{2\,\pi\,L}, \text{ etc.}$$

where x = total correction to be added to the sum of $B + B_1$, x_1 = total correction to be added to the sum of $C + C_1$, etc., to preserve a uniform belt tension, the diameters used in the formula being to the center of the belt.

Proceeding to construct a chart which will give the values of x, x_1, x_2, etc., for any case within its range, we first inspect the formula. We have three main values involved $(A\text{-}A_1)^2$, $(B\text{-}B_1)^2$ and $2\pi L$, the difference between the first two being divided by the last. As 2π is a constant it does not enter as one of the variable factors. The first two factors are to be squared. This is best accomplished in the following manner: Lay out at the top of the chart in lead pencil a uniform scale, in this case the range has been chosen from 0 to 1,000; this represents the values of $(A\text{-}A_1)^2$; now spot off underneath this scale by the aid of a table the square roots of such numbers as will make a fairly uniform looking scale, inserting their values in ink and erasing the former. In this case we wish to subtract from the first quantity $(A\text{-}A_1)^2$ a similar quantity $(B\text{-}B_1)^2$ Since the range of $(B\text{-}B_1)^2$ should be nearly

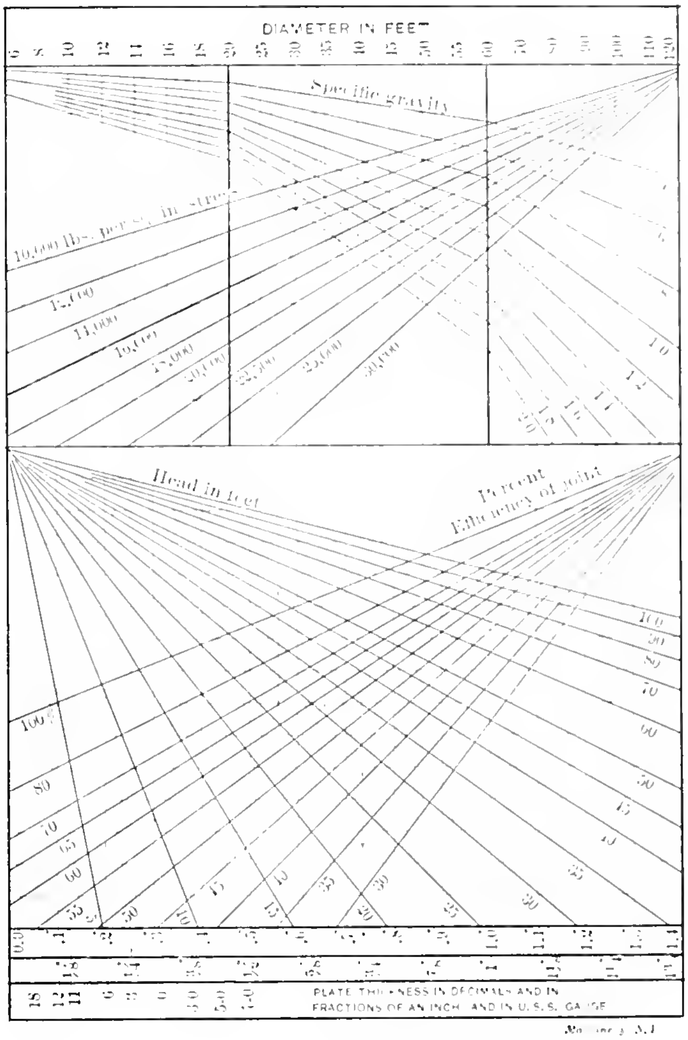


Chart No. 6.

TABLE II. TABULATED FACTORS AND PRODUCTS FOR USE IN SELECTING LIMITS OF READINGS AND SCALES.

	First Factor, Diameter in Feet = D	Second Factor, Specific Gravity = G	First Product = DG	Third Factor, $\frac{1}{\text{stress}} = \frac{1}{S}$	Second Product $\frac{DG}{S}$	Fourth Factor, Efficiency of Joint $\frac{1}{E}$	Third Product $\frac{DG}{SE}$	Fifth Factor, Head in Feet, Constant $= H \times 2.598$	Fourth Product, Thickness in inches
Assumed values which would give minimum final reading	6	.65	3.9	$\frac{1}{25000}$	.000156	$\frac{1}{.80}$	.000195	10 × 2.598	.005
Assumed values which would give maximum final reading	120	2.0	240	$\frac{1}{8000}$	.03	$\frac{1}{.50}$	.06	100 × 2.598	15.6
Practical problem of maximum size it is desired the chart shall handle	120	1.1	132	$\frac{1}{16000}$	.00825	$\frac{1}{.60}$	.01375	40 × 2.598	1.43
Fixed upon as minimum reading	6	.4	0	$\frac{1}{30000}$	.0002	$\frac{1}{1.0}$	0.0	5 × 2.598	0.0
Fixed upon as maximum reading	120	2.	160	$\frac{1}{10000}$	.0086	$\frac{1}{.30}$	.015	100 × 2.598	1.4

the same as for $(A\text{-}A_1)^2$, lay off on one side of the chart the same uniform scale from 0 to 1,000, starting with 0 at the same corner as on the top scale. Now, parallel lines drawn from one value on the top scale to an equal value on the side scale will represent the values $(B\text{-}B_1)^2$, and perform the operation of subtraction; the lines having the same values as their point of origin on the top scale need not be numbered, and the squaring operation having already been performed by the

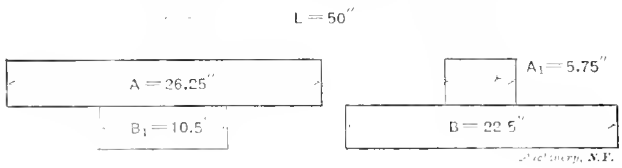
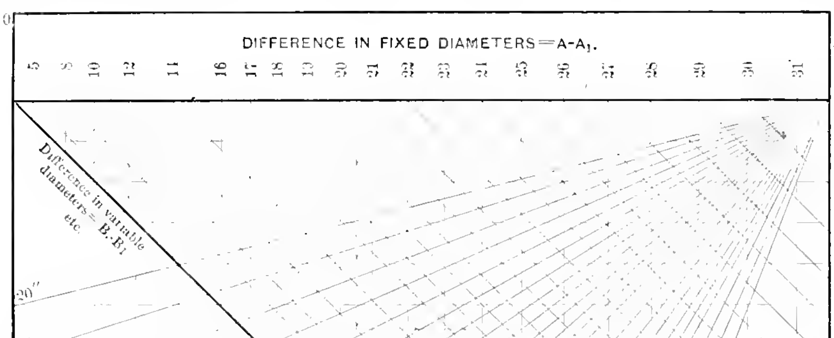


Fig 4

variable scale designate them $B\text{-}B_1$. The values on the side now represent the result of the first operation and are equal to $(A\text{-}A_1)^2 - (B\text{-}B_1)^2$, which value is to be divided by $2\pi L = 6.283L$.

Now lay off a uniform scale on the bottom for values of x, x_1, x_2, etc., which is the required answer. The range of this scale has been chosen from 0 to 2 inches, as this is probably the limit to which one could trust to the accuracy of the chart, since 2 inches increase in the sum of the diameters would make approximately 6 inches increase in belt length.



TOTAL CORRECTION= x, x_1, x_2 ETC.

Chart No. 7.

Choosing the intersection of the 1,000 line of top uniform scale with the zero line of the side scale as a point of origin, draw diverging lines to perform the last operation which is one of division. While these lines have a value of $6.283L$, they are designated by the values of L, the constant affecting the final value only.

Example in a pair of cones, Fig. 4:

$A = 26.25$ inches,
$B = 22.5$ inches,
$A_1 = 5.75$ inches,
$B_1 = 10.5$ inches,

as calculated for crossed belts according to the formula $A + A_1 = B + B_1$, the ratio of speed reduction being fixed by other conditions. $L = 50$ inches. $A\text{-}A_1 = 26.25 - 5.75 = 20.5$ inches, $B\text{-}B_1 = 22.5 - 10.5 = 12$ inches; correction

$$x = \frac{20.5^2 - 12^2}{6.283 \times 50} = .879.$$

Solving this same problem by Chart 7, follow as indicated by the arrows; the result is read off at the bottom as .88 inches, which is near enough for all purposes. If the pair of cones are both to be cast from the same pattern, the corrections need only be carried out up to and including the middle step, as the remaining steps are obviously duplicates of the already corrected ones. The formula upon which this chart is based is said to be nearly correct and practically perfect for a leather belt even on a foot lathe.*

* * *

TRACK INSPECTION APPARATUS.

The increase in speed, load and number of trains on the Northern Ry. of France during the past ten years has led the engineers of the system to adopt a more efficient method of track inspection than that previously used, since the stresses upon the permanent way have been considerably increased in spite of the fact that rails have been increased in weight from 60 pounds to 90 pounds to the yard. The principle of the revised method lies in the substitution of an inspection of conditions for the older one.

It is no longer based on observations derived from an examination of the conditions of the track, which may be modified by impressions that are more or less variable according to the position and temperament of the man who makes them, the condition of the cars from which the observations are made, or the mere external appearance of the section submitted to inspections. It is important that each case should be accurately defined, and that this may be done the vertical and horizontal irregularities of the track must be registered.

The author gives some reports on the methods used to inspect the tracks of the Northern Railway in a rapid and methodical manner and of preserving a record of the work done. These observations are made by means of a registering apparatus placed in a special car, which may be hauled at the rear end of any train. Two platforms located at the ends afford every convenience for an inspection of the track, of noting special points and controlling the operation. The irregularities are registered by inertia pendulums of the Sabouret type, whose oscillations are shortened by the addition of springs. The kilometer posts, the changes of grade and other points are noted on the strip of paper which is moved by a suitable mechanism and on which all results are recorded. The conditions, shown by these diagrams, are then communicated to the several section foremen, whose watchfulness is thus always kept on the alert and who will be held responsible for the repairing of such defects as may be pointed out.—*General Review of Railroads*, December, 1903.

* * *

A rule adopted in some mines is to reject a rope when it ceases to stretch. At this point the rope acquires a permanent set and thereafter the behavior of the material becomes irregular and is eminently unsafe.—*Mining Reporter*.

* This formula was developed by John B. Croker, formerly Chief Designer of the Niles Tool Works. He died about two and a half years ago.

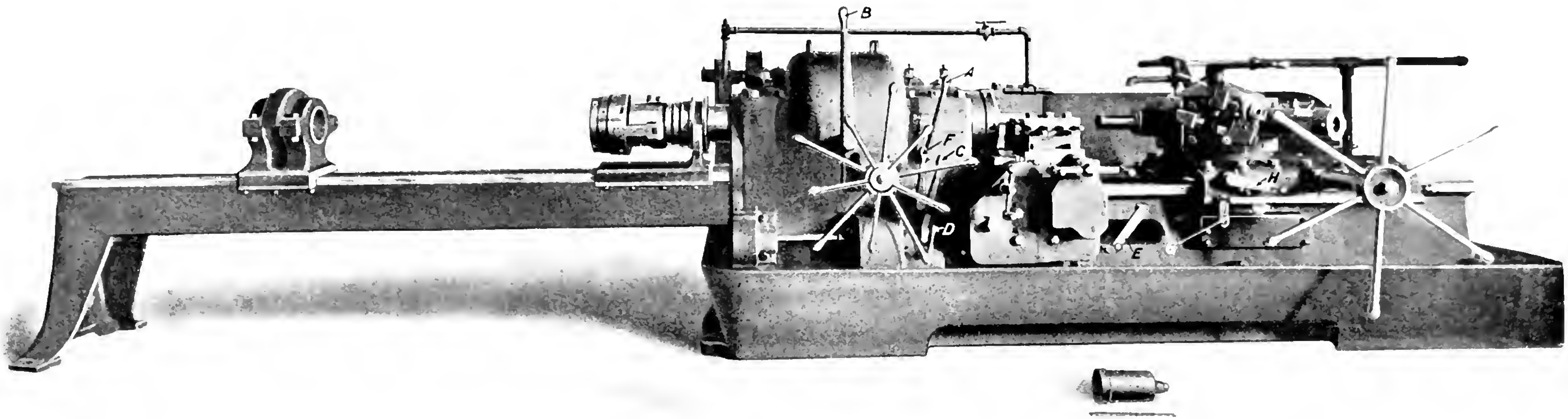


Fig. 1. Heavy Turret Lathe for Operating on Bar Stock up to six inches in diameter. Locomotive Cross-head Pin in Foreground Completed from the Bar in eighteen minutes.

A LARGE BARDONS & OLIVER LATHE.

What is probably the most powerful automatic chuck turret lathe ever built has been shipped by its builders, Bardons & Oliver, Cleveland, O., to the new shops of the Canadian Pacific Railroad Co., Montreal. The lathe is designed for operating on bar stock up to 5 inches in diameter, and is proportioned to meet the exacting requirements of the modern shop where the use of high-speed steel is the rule and not the exception.

Turret machines taking as large as 5-inch round bars have been built before, and are regularly manufactured to-day, but it has been customary on these large machines to use a special type of lathe chuck for gripping the stock. The makers of this machine have adhered to a modified form of the automatic chuck used on screw machines, believing from their experience that no method of holding a bar equals in gripping power the so-called spring chuck or collet, provided it is properly designed and constructed. With this style of chuck the stock is gripped equally around the entire circumference, and the cutting tools can be brought nearer to the spindle bearing than with any other form.

Another departure from the ordinary practice is in the support of the outer end of the bar. There are two usual methods of doing this, one to place a chuck at the rear end of the spindle, which must be opened and closed after each piece is made. The other is to allow the bar to revolve freely in a forked bearing or bushing on the upper end of a light support some distance from the rear end of the head.

In this machine a heavy guide is bolted rigidly to the rear end of the head, and extending far enough to reach the end of a twenty-foot bar when in place in the machine. Sliding on this guide is a carrier, revolving in which is a bushing or chuck, with four screws spaced equally around its circumference. By means of this the outer end of the bar can be made to revolve concentrically with the front end, and almost perfectly round work obtained when using forming tools.

The lathe head is double friction geared, giving four spindle speeds without stopping the machine, and if all three pulleys of the triple friction countershaft, which is regularly furnished with the machine, are used for "go ahead speeds" twelve spindle speeds can be obtained without stopping the machine. The greatest ratio of gearing is about 20 to 1, while the smallest ratio is about 3 to 1. The cone spindle is driven by a 7-inch belt from a triple friction countershaft, with pulleys 24 inches in diameter. The machine can be arranged for motor drive if desired. The construction of the gearing on the cone spindle is of the ordinary back gear type, a sliding wedge which engages the friction through the fingers being operated by the lever *A* on the front side of the head.

The cone spindle is connected with the main spindle through an intermediate shaft carrying a sleeve gear and pinion meshing into the two large gears on the main spindle. These last two gears are loose on the spindle, and either can be clutched to it as desired by means of the lever *B* working through a similar friction mechanism to that used on the cone spindle. Babbitt is used for the main spindle and also the cone spindle bearings. The main spindle bearings are oiled through sight feed lubricators located on the tops of the caps. The front bearing is 8 inches diameter by 13 inches long.

The cone spindle has a hole in the center running almost the entire length, connecting at one end through a stuffing box with a fixed lubricator. Smaller radial holes lead from this central hole to all bearings of the spindle and friction parts, ensuring thorough lubrication, by centrifugal force, from this one source of supply. As this is a fast-running shaft, the necessity of some such arrangement as this can be readily understood. The intermediate gear shaft is lubricated in a similar manner. All gears and rotating parts are fully enclosed.

The combined forming tool slide and cutting-off tool slides constitute one of the most striking features of this machine, and have been designed for the special purpose of producing as much of the work as possible with wide forming tools fed crosswise against the work rather than with end cuts by the turret tools. Experience obtained in the manufacture of

bicycle hubs, projectiles and other irregularly-shaped pieces of circular cross section has demonstrated the superiority of this method wherever practicable. The forming slide, shown in longitudinal section in Fig. 3, is made long and heavy, and carries two massive tool blocks, one at the rear for the roughing tool and one at the front for the finishing tool. Tools to form up to twelve or fourteen inches in length can be held in these holders. The holders are removable and special attachments can be fitted for other classes of work when desired. The forming tools are adjusted vertically by means of taper wedges, which in turn are moved by screws. They are clamped solidly to the holders by bolts passing directly through them. Screws are also provided for the lateral adjustment of the tools. A very little practice enables them to be set quickly and accurately. The forming slide can be fed by hand or power in either direction. The power feed has four changes by means of the lever C, and the reverse is obtained by the lever D, Fig. 1. The feed has an automatic release in either direction. In practice the roughing tool is usually fed by power and the finishing tool by hand. A graduated dial on the handle enables work to be formed accurately as to size.

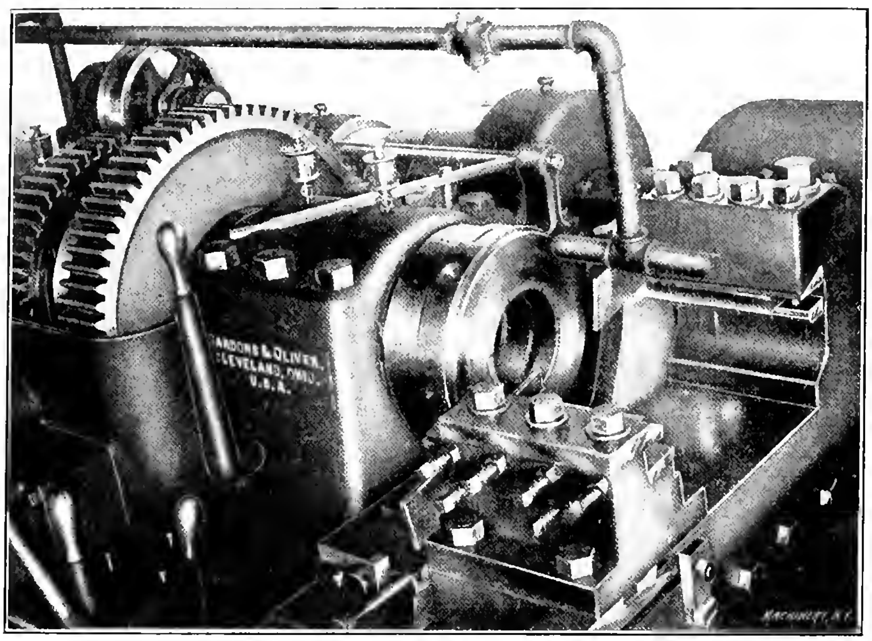


Fig. 2. View of Forming and Cut-off Tool Slides.

The cutting-off tools are two in number, mounted on separate slides, shown in longitudinal section in Fig. 4, which have an entirely independent cross feed from the forming tool slide, although they are carried on the same saddle casting, this saddle having a longitudinal adjustment of $3\frac{1}{2}$ inches by means of the handle E. These cutting-off tool slides are fed in simultaneously by a right and left-hand screw either by hand or by power. The power feed is taken from the same shaft as the power feed to the forming slide, but has separate throw out. The front cutting-off tool slide has an adjustment so that the tools can be set to cut equally. The cutting-off blades are made of high-speed steel and are of special cross section. Four changes of feed can be obtained by means of the lever C.

The turret and turret slide, Fig. 7, while amply large, are not so heavy that they cannot be readily operated by hand. The most severe duty falls on the forming slide, and with this fact in mind great care has been taken in designing the turret and slide not to make it clumsy and difficult to handle. It travels directly on the bed on flat bearings of ample width. Wipers on the front end of the slide keep these bearings clean. A taper gib runs the entire length of one side, and provides means for taking up side wear.

The turret is hexagon in form, and is 18 inches diameter across the flats. An independent stop is provided for each face of the turret, these stops having a range of 36 inches, while the total feed to the turret slide is 42 inches. Each face of the turret has eight $\frac{3}{4}$-inch tapped holes for the purpose of attaching the various tools. There is a $4\frac{1}{2}$-inch hole in each face of the turret and also through the center stud, thus enabling work up to $4\frac{1}{4}$ inches in diameter and 42 inches long to be turned. This diameter can be increased if desired. Power feed to the turret slide is provided, and four changes to this feed can be instantly obtained by means of the lever F, Fig. 1. The power feed can be tripped at any point by each of the independent stops, which also serve as dead stops for the hand feed. The power feed can be thrown in or out by hand by means of the lever G. The lock bolt is withdrawn by hand through the lever H, and the turret is revolved by hand. Means are provided for locking the lock bolt after it is withdrawn, if desired, so that the turret can be revolved in either direction past one or more holes. The lock bolt is tapered on the upper end and fits into hardened and ground steel bushings in the bottom of the turret. It also slides in hardened and ground bushings in the turret slide.

The turret has a large projection on the bottom fitting into a corresponding opening in the top of the slide. This serves to take the major part of the thrust, but in addition to this a taper bushing is inserted in the center of the turret, taking its bearing on the steel turret stud which extends from the under side of the turret slide to the top of the turret. This bushing is adjustable endwise to take up all wear. The turret stud extends through the large washer on the top of the turret, and is threaded on the outer end to receive the binder handle, by means of which the turret and slide can be clamped solidly together.

The stock is held at the front end of the spindle by means of a master collet, Fig. 5. The false jaws are easily changed without removing the collet or collet ring from the spindle, as the jaw screws extend through large holes in the spindle to a point nearly flush with the outside. A sliding ring covers these holes when the machine is in use. The false jaws are usually serrated to increase their gripping power. The collet is closed upon the stock by means of the large turnstile on the front of the head which operates the sliding wedge and fingers on the rear end of the spindle.

Variation in the size of the bar is provided for by making this wedge with three steps. The collet is adjusted by means of the adjusting nut at the extreme rear end of the spindle, so that the fingers rest on the middle step of the wedge when gripping stock of the correct diameter. If the stock comes a little small the fingers are run up to the large step of the wedge; if a little large they stop at the small step, so that the bar is always securely held by the collet.

The feed dog or carrier, Fig. 6, as has already been explained, has been designed to serve another purpose besides the mere feeding of the stock. It is in reality a four-jaw independent chuck, by means of which the stock is not only supported at the outer end, but can be made to run concentrically with the spindle at that point, thereby insuring that the finished piece will be round.

The feed dog is moved along its bed by means of the smaller turnstile on the front of the head. The shaft of this turnstile passes through the center of the shaft of the turnstile which operates the mechanism for opening and closing the collet. It has been customary to make one turnstile serve both of these purposes, but with this construction ample power can be had for operating the chuck, while for feeding the stock forward (which requires comparatively little power) a quick motion of indefinite length is obtained. Connection between the smaller turnstile and the feed dog is by means of an endless sprocket chain.

The base of the machine is cast in the form of a pan. This pan has a large reservoir at the back so that there is room for an abundant supply of lubricant without keeping the pan itself filled. A perforated plate over the reservoir keeps the chips from entering, and the lubricant that runs down

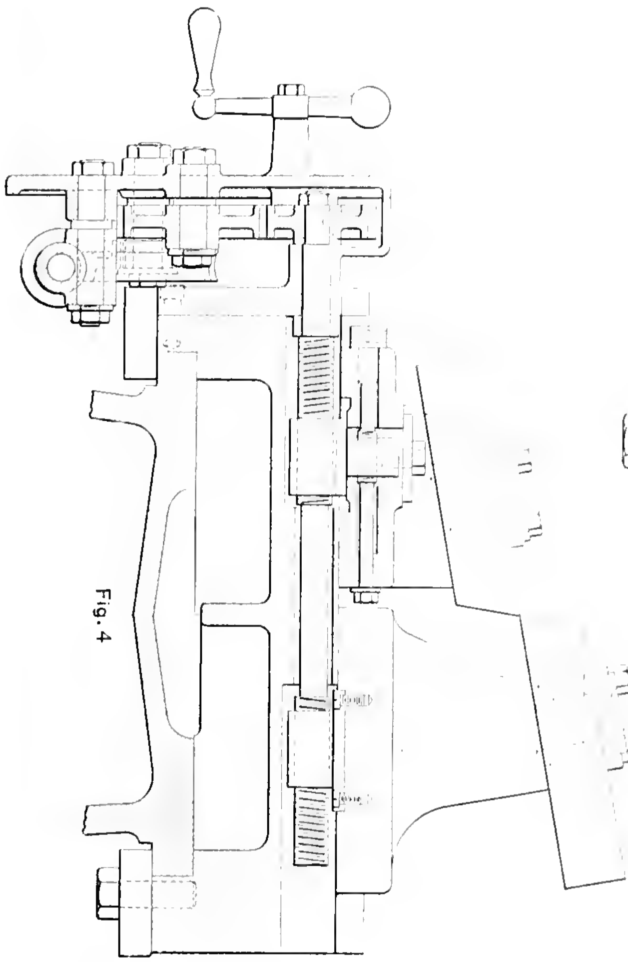


Fig. 4

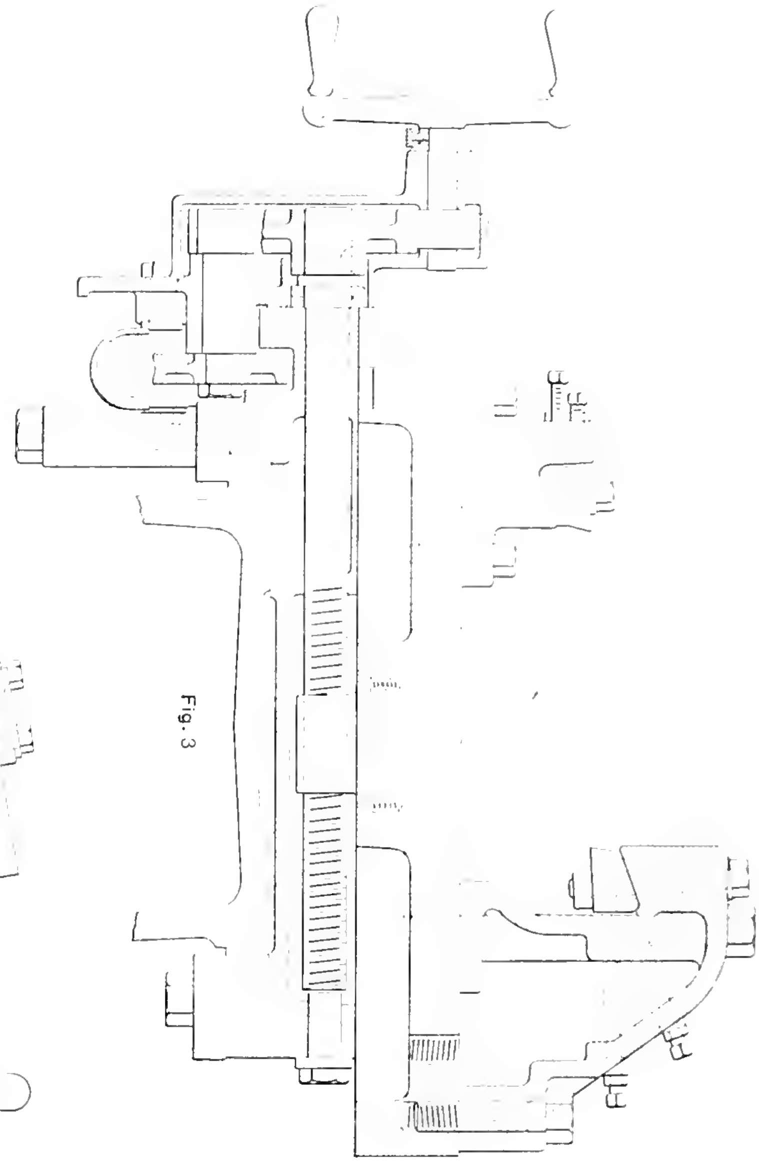


Fig. 3

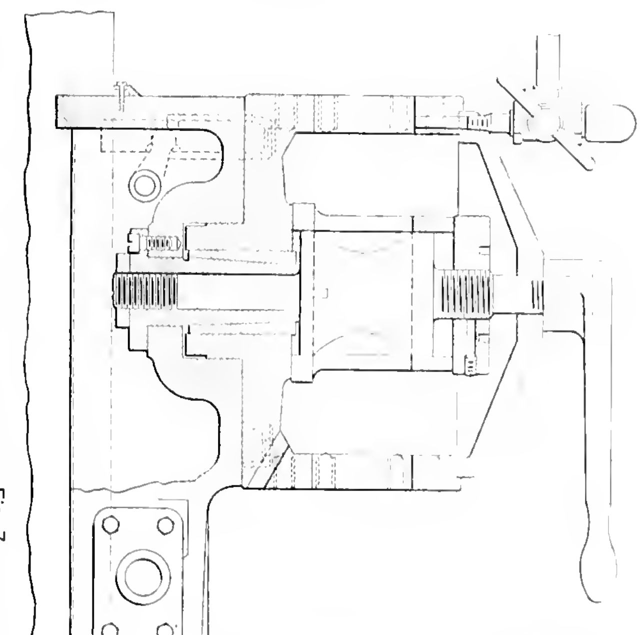


Fig. 7

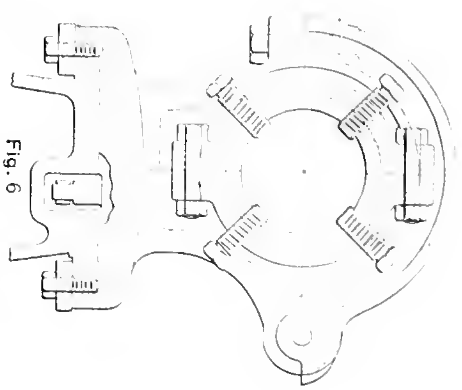


Fig. 6

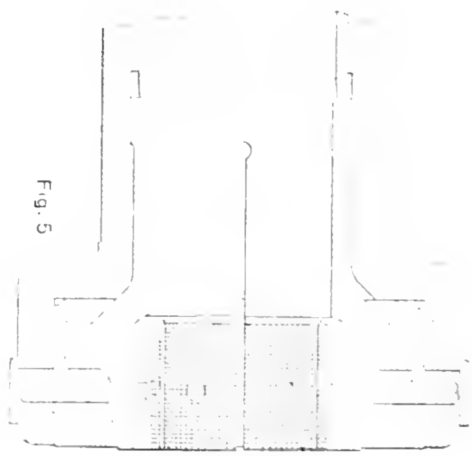


Fig. 5

Some Details of the New Bardons & Oliver Turret Lathe.

Machinery, N.Y.

the front side of the machine is conducted back to the reservoir quickly through an opening under the center of the bed. There is also an opening in the top of the bed between the turret slide and the forming slide, which allows chips and lubricant to fall directly into the back of the pan.

As an example of the capabilities of this machine, in Fig. 8 is shown a locomotive crosshead wristpin which was made from a 4¾-inch steel bar stock, in the remarkably short time of eighteen minutes. The first operation after chucking was to turn down the end to 2 inches diameter from *B* to *C*, which took seven minutes with a box tool. This tool is exceedingly strong. The cutter, which is made of high-speed steel, is provided with a releasing mechanism so that the work will not be scored when the tool is moved back. The tool has two back-rests, which are adjustable in and out, so that the work is able to be backed up at the proper place. The cotter pin end was turned by means of a pointing tool held in a tool-holder clamped to the face of the turret. The 2-inch thread was cut by a self-opening die head with roughing and finishing attachment. The section *A* and *B* was turned and shaped by means of large forming tools of high-speed steel. While the piece was being formed the cutting-off tools were started, thereby saving time. Pieces thus turned out are guaranteed to be within .001 inch of round.

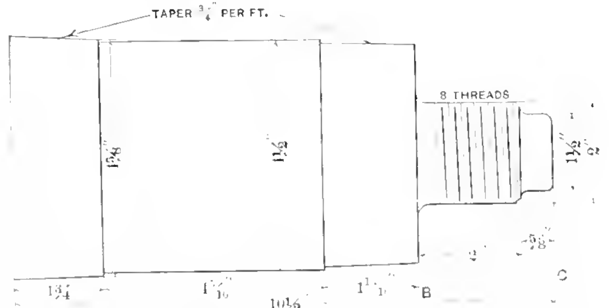


Fig. 8. Locomotive Cross-head pin made from the Bar on a Bardons & Oliver Machine in eighteen minutes.

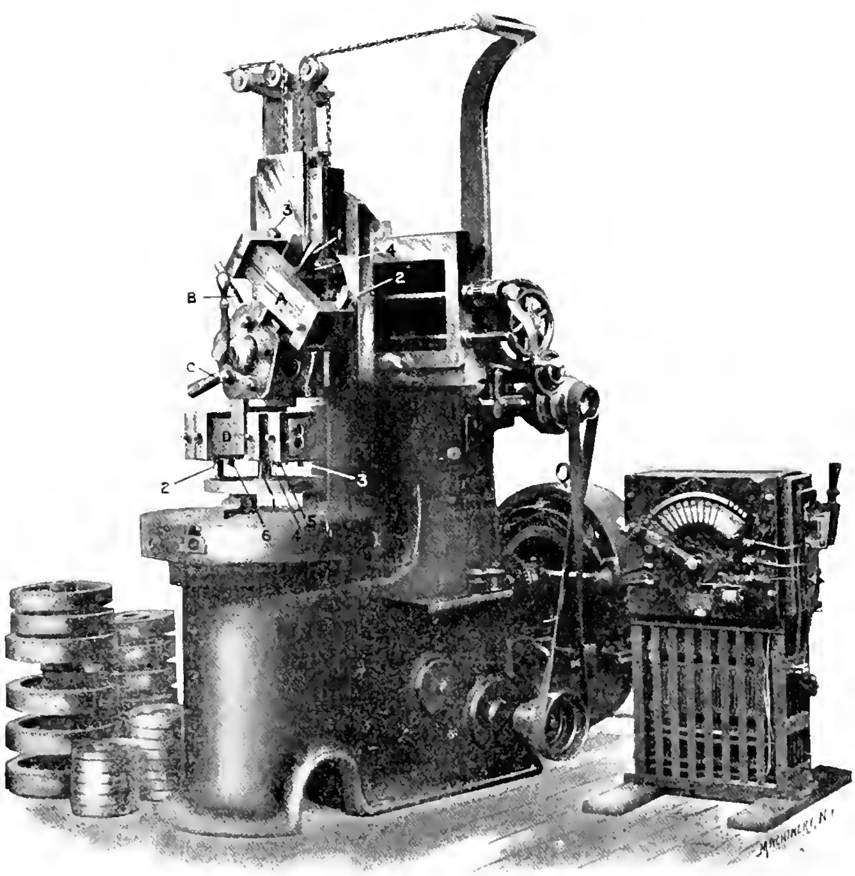
This machine can also be furnished to take bar stock 6 inches in diameter.

METHOD OF FINISHING GEARS AT THE BULLARD MACHINE TOOL COMPANY.

The accompanying illustration of a 30-inch boring and turning mill with turret head, equipped with a full set of adjustable tools for finishing gear blanks ranging in size from 4 inches to 24 inches in diameter with but two settings, will prove of undoubted interest.

The various operations and tool holders therefor are designated alphabetically, and the tools are numbered according to the successive operations performed. The blank is secured by finger jaws gripping inside of rim. It is readily brought to true by the combination chuck in table, and is brought level with the table by the parallel blocks on which it rests.

Tool holder *A*, carrying a four-lip core drill No. 1, outside turning tool No. 2 and facing tools No. 3 and No. 4 for the rim and hub, completely roughs one side of the blank while the hole is being rough bored. Tool *B*—a single-point boring tool—is next run through the bore at a racing cut to insure concentricity, leaving just enough metal to be cleaned up by the special universal joint reamer *C* to finish the bore absolutely true and to size.



Bullard Boring Mill Fitted for Rapid Production of Gear Blanks.

The tool holder *D* is of the same design as *A* but carries a standard size guide plug (No. 1) which, in entering the bore, insures concentricity of diameter, and also adds to the stability of the tool. Tool No. 2 finish-turns the outside diameter of the blank to size and has completed its operation before finish-facing tools No. 3 and No. 4 are brought into action on the rim and hub. The corners of the rim and hub are rounded off by tools No. 5 and No. 6.

In the second setting a stud (the diameter of the bore of blank) is fitted into center of hole in table and a driving stud set in T-slot of chuck jaw. A blank is then dropped over it and tool holder *A*, minus tools No. 1 and No. 2, roughs the faces of rim and hub, which are finished by the corresponding tools in tool holder *D*; the rounds being formed as before.

The method of holding blank from the inner surface of rim insures uniform thickness of the rim when finished, and by the use of the guide plug in finishing tool *D*, the outside diameter is not only turned absolutely true to size but runs on centers within .0005 inch. The tools used in the holders number twelve, and all operations are completed without moving the turret slide from its central position on the rail, thereby saving all time usually required to set tools and caliper for diameters. Most of the tools employed are of the ordinary form and can be used on other boring mill work.

All gears of the above sizes are finished in this way at the shops of the Bullard Machine Tool Co., Bridgeport, Conn., U. S. A., and a saving of from 50 to 75 per cent. is made over the more common method of separate chucking and turning on arbors.

* * *

A hydraulic lift lock was recently completed in the Trent Canal at Peterborough, Ontario, which is a unique piece of engineering on this side of the Atlantic, there being no other example of such work in American canal systems. The Peterborough lift overcomes a difference of level of 65 feet. It consists essentially of two immense steel troughs side by side into which the barges are floated, provision, of course, being made for dropping the end pieces or gates out of the way. These troughs move up and down in vertical guides and one trough counterbalances the other through the hydraulic pistons and cylinders by which they are handled. The rams of the presses are 7½ feet in diameter and have a stroke of 65 feet, working under a gage pressure of 600 pounds per square inch. It is believed that the presses are the largest ever built.

TOOL MAKING.—10.

ARBORS.

E. R. MARKHAM.

Arbors are used to provide a means of holding pieces which have holes passing through them. They may be supported by means of centers, or by portions at the end which fit in recesses of the proper shape and size; or they may have tapered shanks which fit in holes of a corresponding size and taper.

Almost every machine shop is provided with one or more sets of arbors used in providing centers for pieces of work having holes in them and which must be machined after the holes are made. These arbors are slightly tapering in order that work may be tightly forced on them to insure their holding when being machined. This taper also takes care of any *slight* variation that may occur when machining the hole to size. Arbors of this description are generally termed *mandrels*, although in some shops they go by the name of tapered arbors.

Mandrels 1½ inches in diameter and smaller are usually made of a grade of steel that will harden. For those larger than the size mentioned custom varies, some mechanics making them of steel that will harden, while others use machinery steel and caseharden it, claiming it to be sufficiently stiff for the larger sizes. As a consequence they can produce a satisfactory article at less cost than when using tool steel,

Fig. 1.

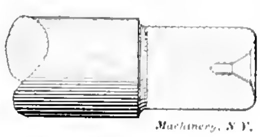


Fig. 2.

or even a low grade of steel having sufficient carbon to cause it to harden when heated to a red and dipped in water. Some mechanics make all large mandrels with the ends hardened, the balance of the mandrel being soft. As local conditions must determine the advisability of using any method, we will consider the operations involved in making them by each method.

When making mandrels from tool steel in the ordinary shop it is the custom, generally, to make them of such grade of tool steel as is in general use in the shop. However, if many mandrels are to be made this becomes a costly method, as a grade of steel can be procured that answers nicely for this class of tool which is much cheaper than steel suitable for the general run of cutting tools. Then again, steel for cutting tools—if efficiency is considered—should be made from a reasonably high-carbon steel; while mandrels are less liable to break or spring when hardened, if made from a steel containing less carbon.

The ends of mandrels are turned to size before hardening. The centers should be deeper than for tools of a corresponding size which are not to run on centers, or which are not to resist as great pressure on the centers when in use. In order that the centers of mandrels may not become mutilated when

Fig. 3.

in use, they should be made as shown in Figs. 1 and 2. The cupping shown removes the outer ends of countersunk portion from liability of mutilation when the mandrel is forced out and in the pieces of work.

The center portion of the mandrel is turned to a size somewhat larger than the finish size, the amount depending on the size of the mandrel and the method employed when hardening. Under ordinary circumstances, however, for mandrels ½ inch in diameter and smaller, an allowance of .015 inch will be found sufficient. For diameters from ½ inch to 1 inch an allowance of .020 to .025 inch; and for arbors over 1 inch, .025 to .030 will be found sufficient. As the length of mandrels larger than 2 inches does not increase relatively to the size, the last amount of allowance will be sufficient for most purposes if proper care is exercised when hardening.

The size of a mandrel should be plainly stamped on the end adjoining the large end of mandrel. This method of stamping should always be observed, as it will save endless confusion.

The corners *b b*, Fig. 3, should be rounded, as shown, to prevent their chipping if the mandrel is driven by means of a hammer. The flat spots *c c* for the dog screw to bear against should be milled or planed. In some shops it is considered

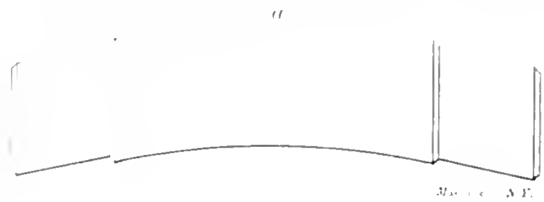


Fig. 4.

advisable to make both of the flats on the same side of mandrel as shown in Fig. 3, while in others they are located on opposite sides. This seems to be a matter of choice, and practice must correspond to the notions in the individual shops.

Before hardening, the centers should be re-countersunk to true them. For this operation a countersink made specially for this purpose should be used, the included angle of whose cutting edges should be 59 degrees instead of 60 degrees, as in the regulation article, as it simplifies the operation of lapping the centers to alignment after hardening. This operation is necessary if we wish a mandrel that will prove satisfactory, as the natural spring of the tool when hardened would throw the centers out of alignment, as shown in Fig. 4. If properly done the operation of lapping will grind these centers so they will bear properly on the centers of the machine.

When hardening extreme care should be exercised in heating, as uneven heating is a more common source of trouble than any other. In order to get uniform heats it is necessary to have a fire adapted to the piece we are to heat. Some furnaces are made which insure uniform heating, while others demand constant attention and considerable skill on the part of the operator to insure satisfactory results. If a blacksmith forge is to be used, have a fire large enough to insure a

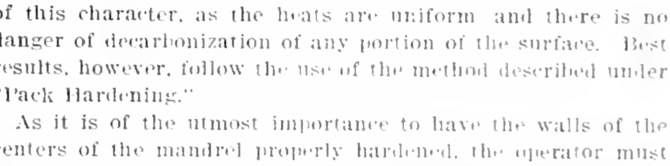


Fig. 5.

uniform heat throughout the piece. In the case of a large mandrel it is necessary to build a large, high fire, or we shall heat the article much hotter in the center than on the ends. A muffle furnace provides an excellent means of heating work of this character, as the heats are uniform and there is no danger of decarbonization of any portion of the surface. Best results, however, follow the use of the method described under "Pack Hardening."

As it is of the utmost importance to have the walls of the centers of the mandrel properly hardened, the operator must assure himself that the contents of the bath have free access to the center holes. This cannot be accomplished if the article is dipped in the bath by means of an ordinary pair of blacksmiths' tongs. In order to accomplish the desired result a pair of the description shown in Fig. 5 should be used.

Where an ordinary bath is used it is considered by many advisable to grasp the mandrel by the large end with the tongs in order that the small end may be the harder; the larger end would be more apt to come in contact with the head center of the lathe when in use and as it revolves with it, it would not be subject to as great an amount of wear.

If many tools of this description are to be hardened it is advisable to "rig up" especially for it, as better results are thus insured. It does not necessarily follow when we prepare in a thorough manner for a certain class of work that we must go to great expense in so doing; many times a comparatively inexpensive equipment answers as well as a more

costly one, and it has the further advantage of not keeping us from making changes when something better is shown us.

By using sufficient care it is possible to heat almost any mandrel of ordinary size and length in almost any fire ordinarily furnished for heating steel; but the use of fires not adapted to the piece are not to be advocated if many pieces are to be heated. It is not, however, advisable to attempt to harden work in a bath that will not give desired results; neither is it necessary as a rule, as baths can be constructed for most purposes at a comparatively small cost.

Now as we wish to harden the entire surface of the mandrel, we shall have best results if we force the contents of the bath against the sides, in order to drive away the steam which forms from the contact of the red-hot metal with the liquid. This steam, if not forced away from the heated metal, forms a cushion around or at portions of the surface, thus keeping the contents of the bath from coming in contact with the steel, causing soft portions or spots.

It is also very desirable that the walls of the center holes be hardened sufficiently to resist wear. To accomplish this we should have a supply of water coming up from the bottom of the bath and another entering it from the top. All this can be accomplished by using a bath of the description shown in Fig. 6, which has several pipes coming up from the bottom. These pipes are perforated to allow the water to be projected against the mandrel. A stream of water coming

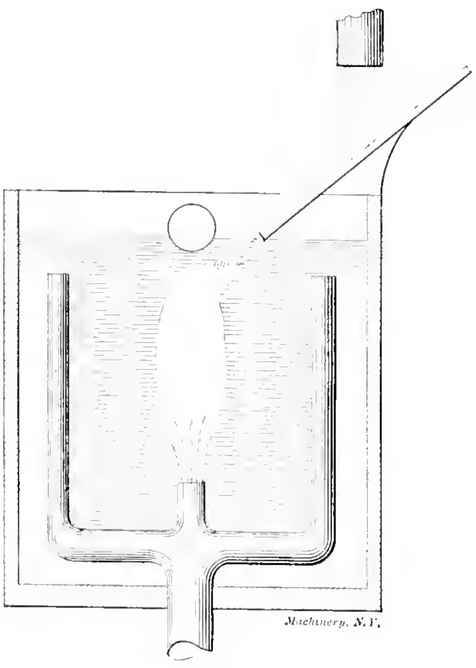


Fig. 6.

up from the bottom strikes the lower end. A pipe may supply a stream at the top of the bath, or water may run onto a board as shown, and running off the board onto the surface of the bath will give a sufficient supply for the upper end. In the absence of such a bath a barrel or tank of water, or brine will answer for small mandrels if these are worked up and down rapidly in the bath. I have hardened a great many articles of this sort in such a bath, but never with such uniform results as when a suitable bath was used. And as such a bath can be made very cheaply by taking an oil, or other suitable barrel, and making the necessary pipe connections, it seems folly to use something not suited to the job, provided, of course, we have a sufficient quantity of work to insure our going to even this slight expense.

As small mandrels would be very apt to break when in use if left as brittle as when taken from the bath, it is necessary to draw the temper of those smaller than ¾-inch diameter to a straw color. In order to do away with liability of chipping the corners of ends of mandrels when driving them in or out of work it is advisable to draw the *ends* of all mandrels to a straw color, leaving the *bodies* of the larger sizes, however, as hard as when taken from the bath. If the ends are softened by tempering, as suggested, the operator must be sure to leave them harder than the centers they are to run on; but as centers are generally drawn to a brown color, the arbor ends, if left at a light straw color, will be enough harder than the centers to insure the centers of the mandrel resisting wear. That is, the lathe centers, being the softer, will wear, which should be the case, as the lathe centers can be easily trued, while if the centers of the mandrel wear the tool is ruined.

After hardening and before grinding, the body of the mandrel should be cleaned of all scale or grease, as this would glaze the emery wheel used for grinding it to size. As long articles if hardened by the methods ordinarily used are liable to be somewhat sprung, they should be tested before grinding to ascertain if they have sprung more than will grind out before they are to size. This can be accomplished by cleaning the scale out the center hole, then trying on centers. If sprung, the smaller sizes may be straightened by the method illustrated in the article on counterbores. In order to straighten larger sizes it will be necessary to heat them as described and straighten them under a screw press or similar device. Generally speaking, however, if due care has been exercised when making and hardening it will not be found necessary to straighten the larger sizes, as they will rarely spring enough to require this operation.

The centers may be lapped to shape and alignment by means of a copper lap of the proper angle (60 deg.) charged with emery. The lap may be held in a drill chuck in the head spindle of a lathe and revolved at a fairly high rate of speed. The opposite end of the mandrel may be supported by the tail center of lathe, and the necessary pressure be applied by means of the tail spindle screw. After the centers are lapped to shape, carefully clean all emery from them by washing in a can of kerosene oil, or in benzine—preferably the latter. If benzine is used care must be exercised that it is not brought near a flame, as it is extremely inflammable.

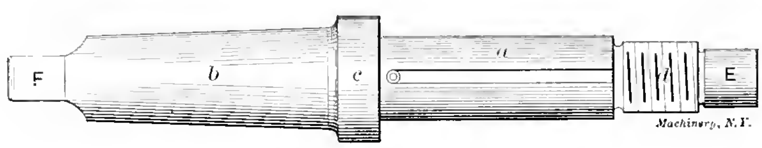


Fig. 7.

In shops where it is used it is kept in a can or dish having a cover which fits tightly. When the cover is removed a rod is passed through a loop in the top which is long enough to allow the cover to be put in place without burning the hands should the benzine catch fire. If it is used at all it should be in small quantities to avoid danger, as far as possible.

As the truth of the mandrel depends in so great a measure on the condition of the centers of the machine it is ground in, they should be carefully examined before using. A mandrel should be ground to size in a universal grinding machine if one is available, as both centers are dead centers; that is, neither of them revolve, the work instead revolving on them. However, if no such machine is available an engine lathe having the necessary grinding attachment may be used.

For work of this character it is best to have a machine which allows the use of water running on the work to keep it cool. In the absence of such facilities, however, it may be ground dry, but the operation is necessarily slower.

If the grinding is to be done on an engine lathe provided with a grinding device we should assure ourselves that the live center is to the proper angle and runs true. Should it *run out* when the mandrel is ground it will cause the piece of work to run out of true on the end adjoining this center. The dead center should be in good condition in order that it may have a good bearing in the centers of the mandrel. The live spindle of the lathe must fit nicely in the boxes, or any irregularities in the belt or the portion where the belt is laced will cause a jump in the spindle which will of course be duplicated on the work being ground. However, if reasonable care is exercised, and the lathe is in good condition, excellent work can be turned out without the latest form of universal grinding machine. In some shops it is the custom to convert the oldest lathe in the equipment into a grinding

lathe and as the work that should be finished by grinding is generally of a character that requires accuracy and truth anything but satisfactory results follow.

The work should be ground to within a few thousandths of an inch of finish size with a coarse wheel, as otherwise it would become heated and spring. Now pieces of steel are very apt to spring somewhat when hardened; it is obvious that when we start grinding it is on the convex side, as shown at *a*, Fig. 4. If we grind with a fine wheel, or one that is glazed we heat the work and this heating is on the convex side; and as the effect of heat is to expand metal it expands or becomes longer on this side, thus springing it still more.

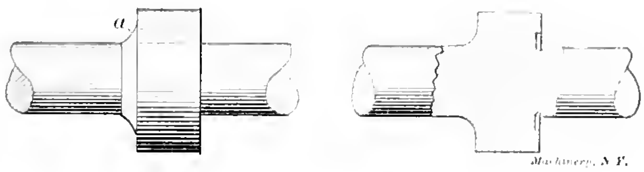


Fig. 8. Fig. 9

Mandrels for ordinary shop equipment are made somewhat tapering. It is generally considered good practice to give them one-half thousandth inch taper to an inch of length, and this seems to give general satisfaction. However, for some purposes it is advisable to give double this amount, or .001 inch to each inch of length, but never unless the pieces that are going on them are comparatively thin, or short. A long piece would get a bearing on only one end and as a consequence the opposite end when machined would be somewhat eccentric to the hole.

Special mandrels made for holding long pieces of work are made nearly, or quite straight, thus insuring a bearing the entire length.

The small end of a mandrel is ground slightly smaller than the size designated—say one-half thousandth inch for ordinary sizes. If larger than 1 inch make it one-thousandth inch smaller.

After grinding to within a few thousandths inch of finish size with a coarse wheel, the work should be finished to size with a fine wheel.

Mandrels with Hardened Ends.

The ends of this form of mandrel are made the same as those previously described. The center is roughed to a size somewhat larger than finish, the amount depending on the size of the mandrel and the method to be used in finishing. If the body is to be ground to size the amount need not be as great as when the mandrel is hardened all over. If, however, it is to be turned to size in the lathe it is necessary to leave considerable more, leaving it, say, 1-32 to 1-16 inch above finish. The ends should, of course, be hardened before

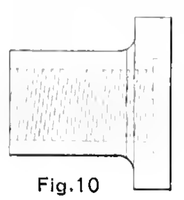


Fig.10

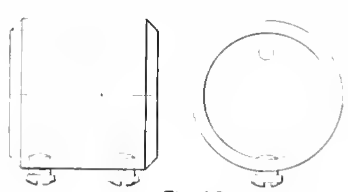


Fig.13

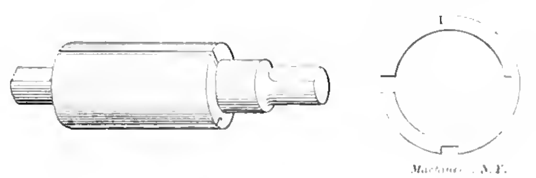


Fig. 16.

the body is finished, which can be accomplished by heating in an open fire or a crucible of red-hot lead, then dipping in a bath having a jet coming up from the bottom. It is necessary, of course, to heat one end and harden it, then proceed with the other end. If the piece is being heated in the open fire it will be found necessary to protect the end first hardened, while the other end is being heated, by covering it with a wet cloth or piece of waste that has been saturated with water. The same instructions given previously for grinding answer when mandrels are made with soft bodies. If the body is to be turned to size look to the condition of spindle bearings and centers.

Making Mandrels of Soft Steel.

When mandrels are made of soft steel, the same general directions given for making of steel that will harden may be followed, up to the operation of hardening. It will be necessary, of course, to caseharden them, which is done by packing in a hardening box, surrounding them with charred bone. The cover should be placed in position and the joints sealed with fire clay mixed with water to the consistency of dough. This is termed luting. After the clay is dry the box may be placed in the furnace and the work subjected to heat for a length of time that will insure its hardening to the required depth.

In order to insure the centers being sufficiently hard it is sometimes considered advisable to sprinkle a little powdered cyanide of potassium in the center holes after the mandrel is taken from the fire, and before dipping in the bath.

The depth of hardening necessary depends in a measure on the nature of the work to be machined on the mandrel and should be deep enough to prevent its being mutilated by carelessness.

Taper Mandrels.

This form of mandrel is made in the same manner as the ordinary form except that the body is of the desired taper. If other means are at hand it is not advisable to turn the taper on this form of tool by setting over the tailstock of the lathe, as this method has a tendency to distort the center holes; a lathe with a taper attachment should be used if

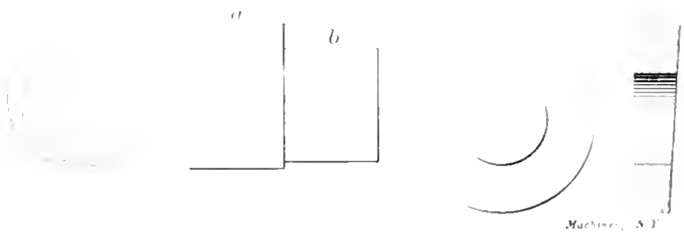


Fig. 11. Fig. 14

possible. If no such attachment is to be had and it is necessary to set over the tailstock, the centers may be carefully recountersunk before hardening.

If possible, grind taper mandrels on a universal grinding machine. If such a machine is not at hand and the lathe must be used by setting over the tailstock, exercise all the care possible to prevent distorting the center holes.

Milling Machine Arbors.

This form of arbor should be made from a stiff steel. As a rule crucible tool steel is used. Where many arbors are to be made it is advisable to use a cheap tool steel, or a machinery steel sufficiently stiff to prevent its springing when subjected to strain incident to arbors of this class. A good grade of open-hearth steel containing 60 to 70 points carbon answers nicely, and the arbor, or portions of it, may be hardened if desired.

Arbors of this class may be forged to shape, being left large enough to machine to size, or they may be turned from stock a trifle larger than the largest part; or they may be made from stock sufficiently large to turn to the size of shank (*b*) Fig. 7, or body (*a*); and the shoulder (*c*) made as a separate piece and shrunk on. If this method is followed it is advisable to leave a portion of the stock somewhat larger than the hole in the piece we are to shrink on, as shown in Fig. 8 at *a*. This prevents the shoulder *c*, Fig. 7, from moving if it is subjected to severe strain when tightening the nut. Another method consists in welding the shoulder *c* onto a piece of steel of the desired size.

After turning in the lathe to dimensions 1-16 inch larger than finish size the ends *E* and *F* should then be turned so that *E* will be .015 large in order that it may be ground to size after hardening, while *F* is brought to size and the tenon milled as shown. After this the centers should be recountersunk and the ends hardened. After hardening, the end *E* should be drawn to a full straw color, and *F* to a deep brown

The portion d should be turned to size and threaded to receive the nut, which should be made and hardened before this portion is threaded.

If a lathe having a taper attachment is not available, and it is necessary to turn the tapered shank b by setting over the tailstock, it should be turned before the portion a. If a grinding machine is available, a and b should be left .018 to .015 inch large and ground to size. If the portion a is to be ground the arbor should be splined before grinding.

Before splining, a hole should be drilled a trifle deeper than the depth of spline cut, and with a drill a little larger in diameter than the width of the spline slot. This hole is to furnish a place for the tool to stop in when cutting the spline slot. This operation should be done in the shaper or planer.

It was formerly customary to make the slots in arbors and milling machine cutters in the form of a half-circle. When the cutter was placed on the arbor a complete circle, more or less irregular, was formed. A piece of drill rod was used for a key. This method has been superseded in most shops by slots having vertical sides and which receive a square piece of stock to keep the cutters from turning on the arbor.

Fig. 12.

If the portion of arbor marked a, Fig. 7, is ground to size, it is advisable to grind the side of the shoulder next this portion in order that it may be at right angles and perfectly true with this portion, which may be accomplished very nicely if the side is made as shown in sectional view, Fig. 9.

It is customary to make nuts for arbors of machinery steel, which are casehardened when completed. They are made by placing the blank in a lathe chuck, drilling, boring and threading to the desired size. If a tap of the proper diameter and pitch is at hand the thread may be cut with an internal threading tool nearly to the proper depth, then finished with the tap. If a tap is not available it may be threaded to size with the threading tool. The outer end should be faced, and the threads at the end turned out for a distance of 1/8 to 1/4 inch. It may then be placed on a nut mandrel and finished. After the sides to receive the wrench have been milled the nut may be hardened. After hardening it is advisable to square the end a, Fig. 10, by grinding, in order to correct any irregularities caused by hardening. When grinding it is necessary to screw the nut onto a nut mandrel which runs perfectly true.

Eccentric Mandrels.

When it is necessary to machine a piece of work similar in form to that shown in Fig. 11, or any piece having a portion which is eccentric to the hole, it is necessary to have an arbor

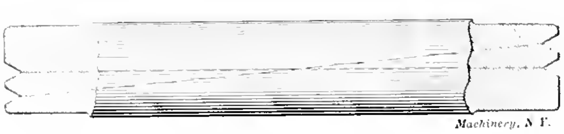


Fig. 15

which has a pair of centers in its ends located in the proper position to give the desired amount of eccentricity. If the piece is of the form shown in Fig. 11, then the portion marked b may be turned with mandrel running on the regular centers, and the portion a with it running on those which are eccentric to the outer surface. Fig. 12 shows a mandrel of this type.

When making this style of mandrel the instructions given for making the common form of mandrels should be observed, except that with the exception of large mandrels it will not be found advisable to cup the ends around the centers, or at least but very little.

There are several methods employed when locating the eccentric pair of centers, the method used depending on the accuracy necessary to observe when machining the work. If extreme accuracy is not essential the mandrel may be placed, before hardening, between the centers of a lathe. Having previously set a surface gage needle at the height of the point of the lathe centers, now draw a line on each end of the mandrel from the center to the circumference. The needle may be raised the proper amount to produce the desired eccentricity. The mandrel may be turned one-quarter revolution to bring the lines scribed on ends in a vertical position at the top of mandrel. Then lines may be scribed which will intersect the vertical lines at the desired distance from the center. Prick punch the ends where the lines intersect, after which the eccentric centers may be drilled and countersunk. If care is exercised when doing these various operations the result will be near enough exact for most work.

The same result may be accomplished if the mandrel is held in a V-block on a bench plate and the centers laid off by means of a surface gage. In this case, however, it will be necessary to caliper the ends, set the surface gage needle to the height of the top of end, then lower a distance equal to one-half the diameter of end.

If the eccentric centers must be of an exact distance from the center of mandrel and just alike, it will be advisable to make a jig of the form shown in Fig. 13. In order that the jig may do accurate work it will be necessary to turn the ends of mandrel so they exactly fit in the jig. A line must be drawn on the jig, as shown, then a line must be scribed the entire length of mandrel, or at least on each end, to set the jig by, in order to insure exact alignment of the eccentric centers.

It is sometimes necessary to face pieces of work as shown in Fig. 14, the one side to be at right angles to the hole, the opposite side to be at an angle as shown. This may be accomplished by making a mandrel having its eccentric centers on opposite sides of the center holes, as shown in Fig. 15. Either style of mandrel, Fig. 12 or Fig. 15, may, after hardening, be ground to size on the concentric centers.

When there is a slight variation in the size of holes in pieces to be machined on mandrels, a form known as an expansion mandrel is many times used. Not only will any slight variation be taken care of, but the mandrel bears the entire length of the hole in the piece as the bearing points of the mandrel expand on parallel lines. There are several styles of this form in use. That in Fig. 16 gives excellent satisfaction and is easily made. The mandrel proper is made sufficiently tapering to give the desired amount of expansion. It is hardened and ground to size, the sleeves are made with holes of a taper corresponding to the taper of mandrel and they are then split as shown. After the burrs are removed from the hole the shell is placed on the mandrel and ground straight and to the desired size. If a taper expansion mandrel is wanted the outside of sleeve may be given the desired taper. A valuable feature of the expansion mandrel is that it expands into the hole in a piece of work instead of being pressed through it. However, when it is desirable to maintain accuracy as to concentricity expansion mandrels are seldom used.

* * *

Ammonal is a new high-power explosive adopted for the bursting charges of shells by the Austrian Government. Like thermit one of its principal ingredients is powdered aluminum. The other principal ingredient is nitrate of ammonia, hence the name. Unlike guncotton, dynamite, lyddite, melinite and other high-power explosives that have been tried with little or no success for the bursting charges of shells, ammonal cannot be exploded by shock, but, like common black powder, it must be fired with a fuse. For this reason it is likely to become considerably used in the arts of both war and peace. It is the invention of Herr Hans Van Dahmen and is manufactured in the explosive works of Mayr & Roth, Felixdorf, Austria.

* * *

A recent consular report refers to a new application in Australia of the principle of the coin-in-the-slot machine, stating that if a stamp cannot be purchased conveniently it will be possible in the future to drop a letter into one orifice of a postal box and a penny into a second orifice, and the words "one penny paid" will be found impressed on the envelope when the box is opened by the postoffice authorities, thereby securing the transmission of the letter.

SOME ENGLISH LATHES.

JAMES VOSE.

In small, and even fairly large, shops the question arises: "How may we best obtain as great a proportion as possible of the benefits of a modern special turret lathe without sacrificing the 'all-round' handiness and capacity of the ordinary screw-cutting lathe?" Moderate cost is, in this connection, generally a matter of moment. The illustrations and particulars herewith indicate how one English concern—Clark's Engineering Co., Ltd., Luton—have endeavored to fulfill these conditions. Readers will form their own conclusions as to how far these efforts are successful from the sketch and time given for the job in Fig. 4. Before describing the tools more nearly answering the description of turret lathes, the 6-inch lathe, Fig. 1 (swinging 12 inches over bed) is a recent example of what in English phraseology is generally described as a "self-acting, sliding, surfacing, and screw-cutting lathe, with gap bed." It will be noted that, with a view to obviating the theoretical disadvantages of the gap bed—the springing of the bed out of alignment—the makers place the left hand leg, which acts as a change-wheel cupboard, underneath the gap—a plan first adopted, I believe, by Mr. Geo. Richards. The

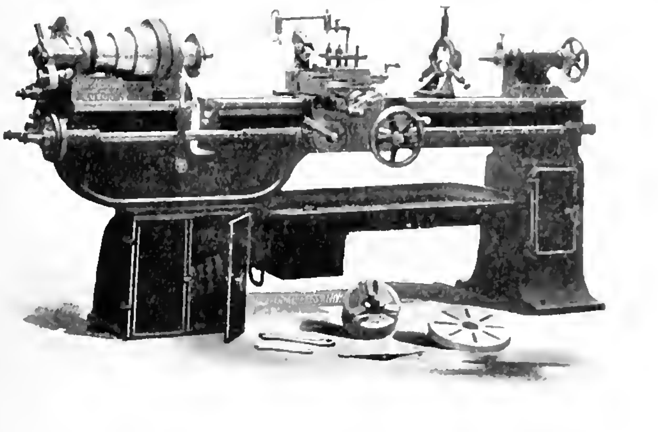


Fig. 1. Type of English Gap Lathe.

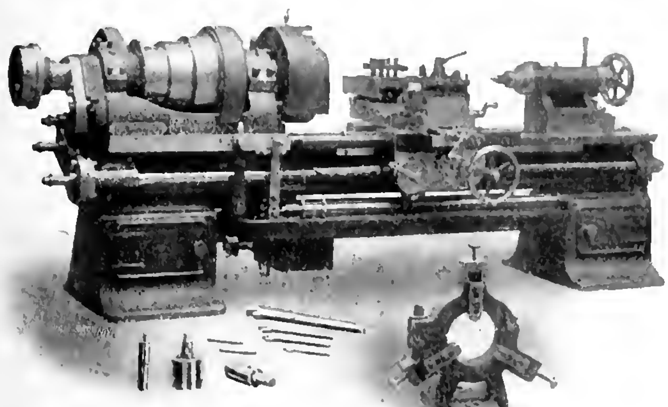


Fig. 3. Eighteen-inch Hollow Spindle Lathe for Operating on Bars four inches Diameter or less.

gap enables a job 24 x 7½ inches to be swung for boring, etc. Each step of the cone pulley is 2½ inches wide, and the diameter of poppet spindle is 1¾ inch. Three changes of feed are instantly available for sliding and surfacing. The characteristically British four-stud slide rest has a base almost the full length of the slide. On the transverse feed screw is the notched dial wheel of a "quick withdraw" motion, used when screw cutting, for drawing away the tool on the return traverse, and bringing it to its previous position ready for the next cut. The cut-away tailstock, popularized by American makers when they first endeavored to cater to British requirements, is arranged with transverse slide for taper turning, etc. The hinged steadyrest is also designed on American lines. The position of the traveling rest may be moved in the direction of the length of the bed, a facility well worth having. The lathe is fitted with a hollow spindle to take a 2-inch bar. The sud pump and chips pan are an optional portion of the outfit. As in other lathes by this company, the center holes are Morse taper. When the lathe is built to take a job 3 feet long between the centers its weight is 2,264 pounds.

In the hollow spindle capstan lathe, Fig. 2, which swings 16 inches and deals with 3-inch bars, the saddle is arranged to slide past the chuck, when desired, as in some of the more recent American heavy turret lathes. The automatically revolving turret is arranged with six stops. As in the lathe Fig. 3, the headstock bearings are parted diagonally, which would appear to tend toward steady running. The pump, sud fixtures, and splash trap allow of a wide range of brass and steel work to be dealt with in the general shop. The universal chucks generally fitted on these lathes are made by Chas. Taylor, Birmingham. When on a 6-foot bed the weight of this tool is about 2,100 pounds. In the 18-inch swing lathe, Fig. 3, the hollow spindle takes a 4-inch bar, with bed 9 feet long takes 4 feet 2 inches between the centers, and weighs over

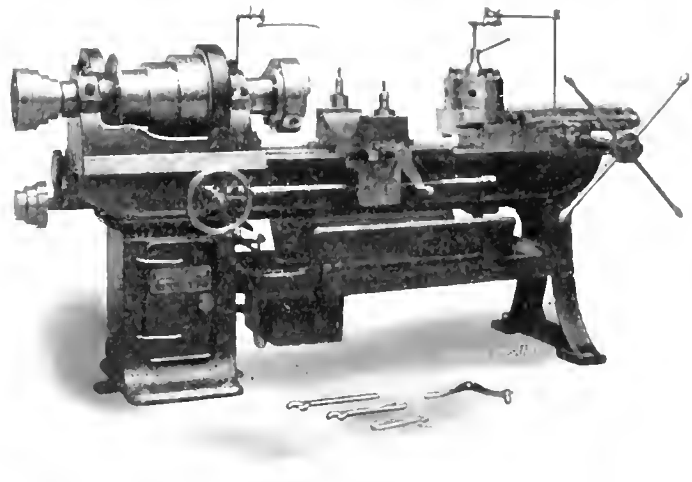


Fig. 2. Turret Lathe.

6,000 pounds. The usual three quick change feeds are available, and the sliding saddle is controlled by six longitudinal stops. The width of steps on the belt cone is 4 inches and the ratio of back gear is 11 to 1. Self-centering chucks are fitted at both ends of the spindle. The loose poppet-head is secured to the bed by two 1-inch bolts and a plate the full length of head. The diameter of the spindle in loose head is 3¼ inches.

The accompanying dimensioned sketch of a job produced complete from a 6½ square steel bar will give a better idea of the metal-removing capacity of the tool than any lengthy description. It will be noted how the outer end of the poppet spindle is notched to suit the projections on the drill socket, thus preventing scoring of the center hole when boring work. A 14-inch swing by 7 feet 8 inch bed by 3-inch bore hollow spindle lathe, built on the same lines as the above weighs 3,700 pounds, and takes 3 feet 8 inches between centers. The width of belt cones is 3½ inches, the ratio of back gears is 10 to 1 and the diameter of loose poppet spindle is 2 inches. The saddle is fitted in front with a 4-tool square turret and depth

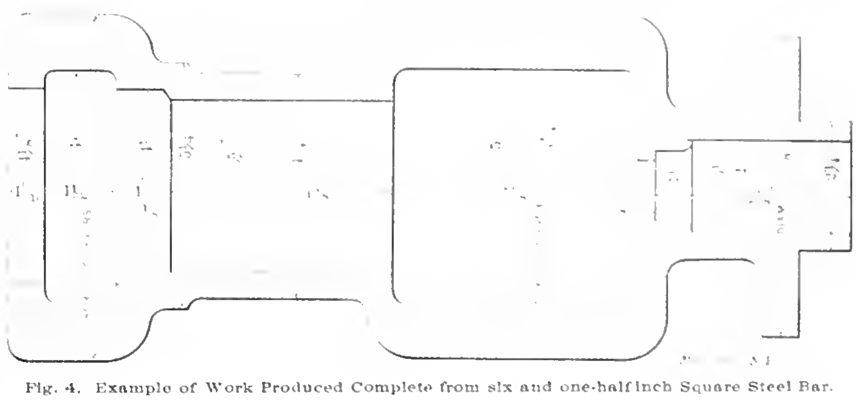


Fig. 4. Example of Work Produced Complete from six and one-half inch Square Steel Bar.

stops and at the rear with a cut-off and forming slide arranged also if desired to carry a die head of the Jones & Lamson or Geometric type. These features as well as an automatic feed to the poppet spindle, worked by gearing from the back spline shaft are applied to both the 14 and 18-inch swing lathes. It is claimed that these lathes are easily capable of utilizing the peculiar features of the latest high-speed tool steels, the cutting tools giving way before checking the speed of the lathes. In conclusion it may be mentioned that the

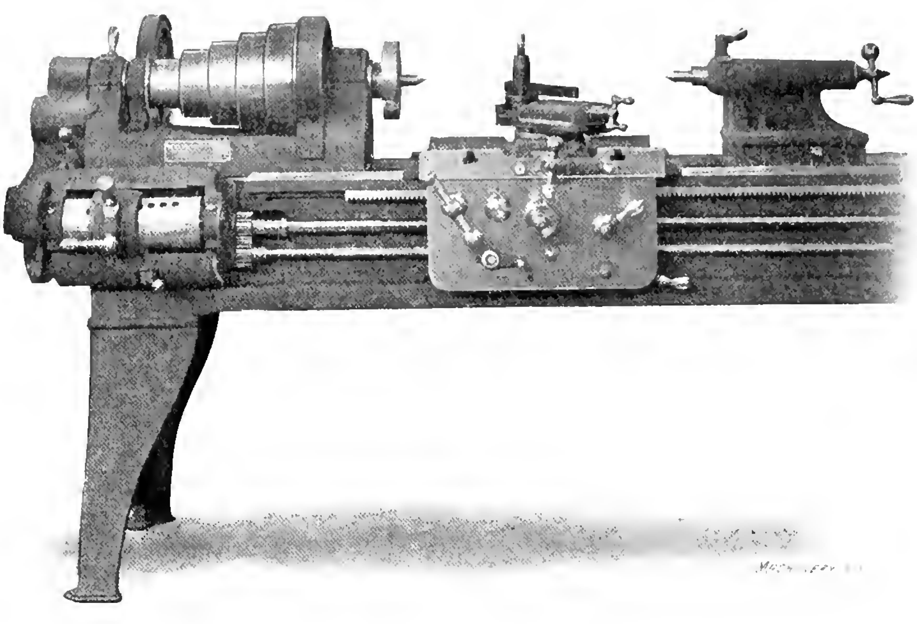


Fig. 1. Sixteen-inch Le Blond Lathe.

subject of quick removal of metal is exciting great interest in Great Britain, scarcely a week passing without a discussion taking place on the topic, or a new lathe for the purpose being placed on the market.

* * *

LE BLOND LATHE WITH QUICK CHANGE GEAR DEVICE.

A new quick-change gear lathe has been placed on the market by the R. K. Le Blond Machine Tool Co., Cincinnati, O. The lathe is fitted with a feed box containing a nest of gears for transmitting motion to the feed rod and leadscrew. These details as well as the gear connection between the feed box and the lathe spindle are shown in the accompanying engravings. The lathe, with the exception of these features, is the same as the standard engine lathe built by this company, and the headstock end is shown in Fig. 1, which gives a good idea of the exterior appearance of the change gear device.

The line drawing, Fig. 2, shows the connection between the feed box and the lathe spindle. The spindle gear A drives gear D on the stud D_1 through tumbler gears B and C. The tumbler gears are of the regular construction used for reversing the motion of the carriage in screw cutting, so as to cut either right or left-hand threads, as required.

Motion is transmitted from the tumbler gears through gears D, E_1, G and H, which latter is on the driving shaft of the feed box. In order, however, to obtain a second series of feeds there is a telescopic slip gear located on the stud D_1 which can be made to mesh with gear G in place of pinion E_1 which is shown in mesh with gear G in the engraving. To accomplish this G rotates on a pin in a quadrant G_1 which by means of the clamping handle G_4 and the stops G_2 and G_3, can be brought into the correct position for gear G to mesh either with pinion E_1 or gear F, as required. The hub of gear F is recessed so that it can be slid over pinion E_1, thus bringing this gear in the same plane with gear G. Gears D and F and the pinion E_1 all rotate with the stud, which is journaled in a bearing in the headstock casting. The introduction of the telescopic gear F makes a change in the feed ratio of 4 to 1.

Fig. 4 is reproduced from the patent specification and shows clearly the mechanism of the feed box. A is the driving shaft and B the driven shaft, which in this case is represented as being one end of the leadscrew, but in the actual lathe is connected with the latter by suitable intermediate gearing. However, the principle of the feed changes is the same in either case. Shaft B carries a cone of gears and shaft A an elongated spur gear C, which is the driving gear of the mechanism. Surrounding C is a cylindrical barrel D, which serves the double purpose of a casing for this gear and a bearing for a sliding bushing E, by means of which the adjustment of feed is effected. This bushing carries at F an intermediate gear which at all times is in mesh with gear C and can also be brought into mesh with any one of the gears in the cone by giving the bushing E a combined sliding and rotary motion on the barrel D. The portion of the barrel D which is toward the cone of gears is provided with a longitudinal slot, to allow the intermediate gear F to project through and mesh with gear C. The front portion of the barrel is provided with a series of holes, corresponding in number and position to the gears of the cone, so that the bushing which carries the intermediate gear F can be locked in its proper position for each gear by means of a spring pin, after the usual manner. The bushing which acts as carrier for the gear, and the barrel which encases the elongated gear, are clearly represented in the general view of the mechanism, Fig. 3.

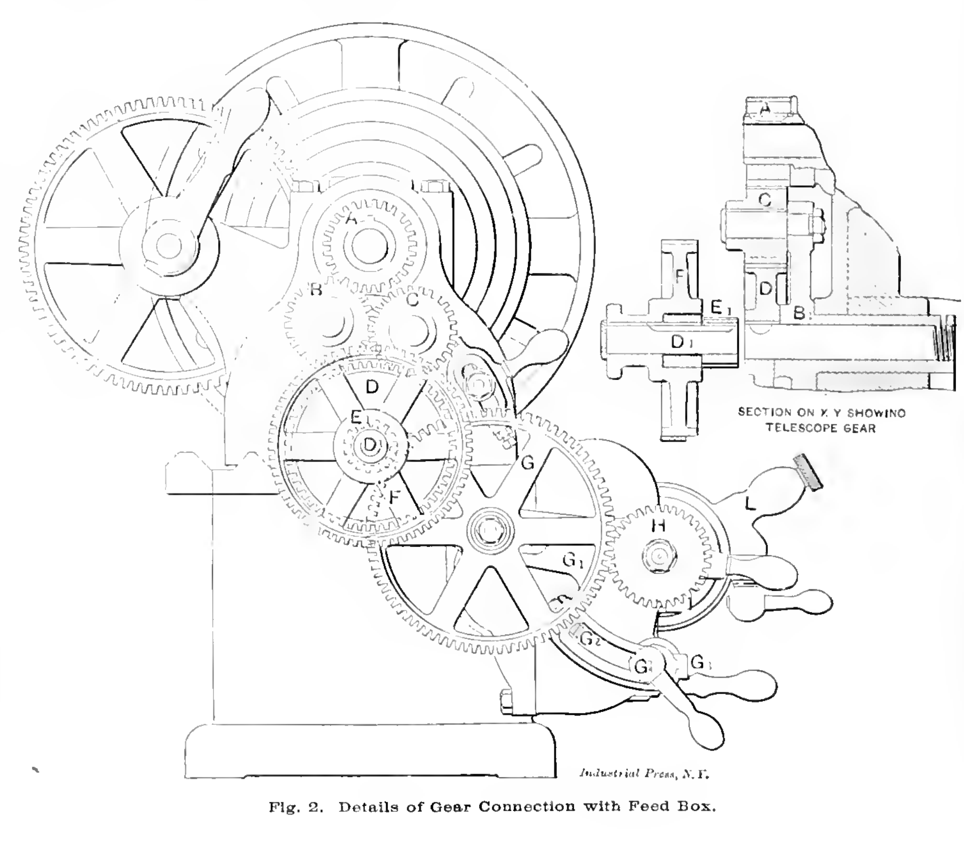


Fig. 2. Details of Gear Connection with Feed Box.

Fig. 5 is a view looking at the rear of the mechanism and its casing, and shows the modifications that have been made in the device to adapt it to the engine lathe. The cone shaft carries besides the eight gears of the cone an additional gear, *K*, and below this shaft, which is marked *B*, is the shaft *L*, which is connected directly to the feed rod, *R*, and carries a sliding sleeve, *S*, on which are two pinions, *M* and *N*. In

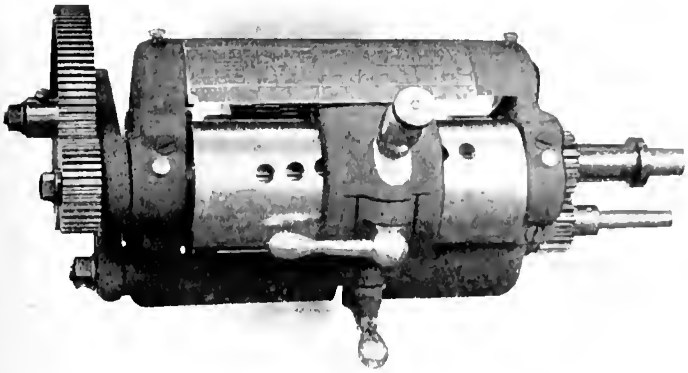


Fig. 3. Feed Box containing Gear Cone.

the position shown in this view power is transmitted from the cone shaft *B* to the gear *N* by means of the auxiliary pinion *K*, and as the sleeve *S* is splined to shaft *L* the motion is transmitted to this shaft and thence to the feed rod. By sliding the sleeve to the right, gear *N* no longer meshes with pinion *K*, but instead pinion *M* meshes with one of the gears of the cone, causing the feed rod to rotate at a faster speed. The leadscrew *T* is driven from the feed rod by a slip gear, *W*, in the usual manner.

In the general view, Fig. 3, the quadrant and the pinion on the shaft with the elongated driving gear appear at the left, while the upper shaft at the right is the leadscrew and the lower one, the feed rod. The slip gear, by which an additional set of speeds is obtained for the feed rod and leadscrew is operated by the handle on the bottom of the engraving.

From the above description it will be seen that with the gear box itself, eight changes of feed are obtained. The slip gear on the auxiliary shaft in the feed box makes 16 changes, and these 16 changes are again doubled by the telescopic gear on stud D_1, in Fig. 2, making 32 changes and giving a range of threads from 3 to 46 per inch, covering every standard thread, including 11½.

This entire range of threads can be made without stopping the lathe or removing a single gear. The feeds are four times the number of threads per inch. It will be noticed that the compounding generally adopted on this style of lathe is done away with, and that wherever there are coarse feeds or heavy threads the increase comes directly from the 4 to 1 gear on the stud D_1 speeding up the feed mechanism of the feed box in the same proportion, so that it is placed under no additional strain.

* * *

THE IRON THAT GAVE US LEADERSHIP.

The economic results of the discovery and development of the Mesabi range of ore form one of the most important industrial facts in the past half century, says F. N. Stacy in the *World's Work* for September. Since the first shipment from the Mesabi in 1892, the iron ore production of the United States has increased from 16,000,000 to 35,000,000 tons per annum; the pig iron product from 9,000,000 tons to 18,000,000; the steel output from a little more than 4,000,000 tons to 15,000,000; while the iron and steel exports of the United States have grown from about $25,000,000 a year to $120,000,000. During these dozen years, we have become the greatest iron and steel producing country. The Mesabi was the greatest single factor in this achievement, and, without the vast resources of the Mesabi, the present dominance of the United States in iron and steel would have been delayed perhaps for decades. A sixth of the annual iron-ore product of the world—which is more than a third of the yearly production of America—comes from an iron range that was unknown in 1890. The Mesabi range on Lake Superior yields ore enough to make as much iron and steel as all Great Britain makes; and her industrial dominancy was founded on iron. During the fifty years ending December 31, 1903, the Marquette range on Lake Superior yielded more ore than any other mines; but the Mesabi range has produced almost as much in twelve years as the Marquette produced in fifty. In the use of steel, the cheap and abundant ores of the Mesabi have produced a revolution. They have enabled the railroads, within the past

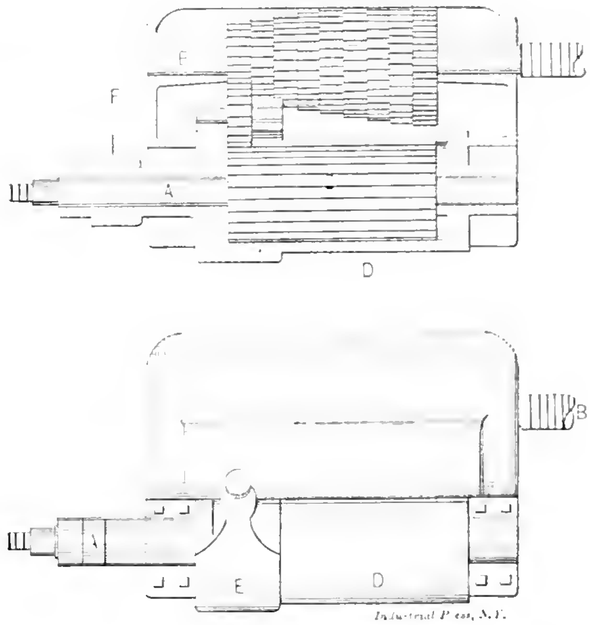


Fig. 4. Reproduction of Patent Drawings of Details.

six years, to relay, with heavy steel rails, almost the whole rail mileage of the United States. Steel cars, steel ties, steel bridges, steel warehouses, steel ships, steel construction for a thousand purposes for which wood and stone were used before, have followed. Exports of agricultural implements have multiplied five times in ten years. The tonnage on the Great Lakes has doubled. Finally, the iron tide from this vast iron deposit flowing into the channels of industry at the following rate of progression—4,245 tons in 1892, 1,793,052 in 1894, 2,882,079 in 1896, 4,613,766 in 1898, 7,809,535 in 1900, and

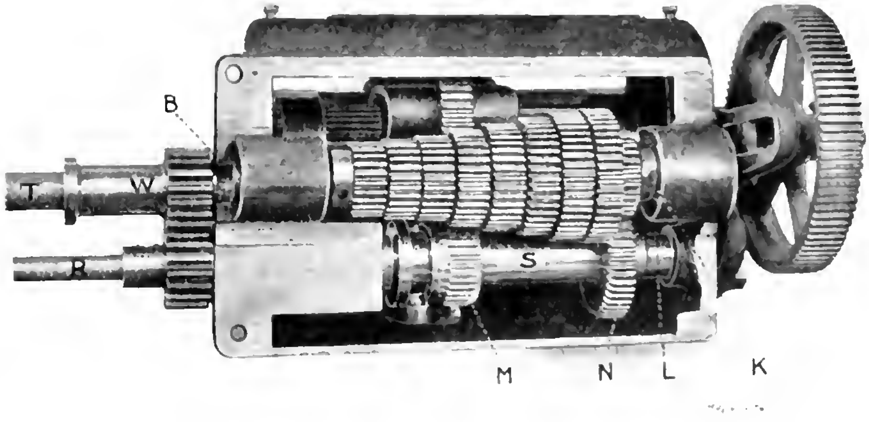


Fig. 5. Rear and Interior View.

13,342,840 tons in 1902—was one of the most powerful factors in the industrial and commercial revival of the United States after the panic and depression that began in 1893; and the impetus it gave our material progress continues to be world-wide.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

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SEPTEMBER, 1904.

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MACHINERY is ten years old this month.

* * *

THE TREND IN STEAM TURBINE CONSTRUCTION.

Steam turbines may be divided into two classes, comprising those of the reaction type, like the Parsons turbine, and those of the impulse type like the De Laval, the Curtis, Rateau and Zoelly. In a reaction turbine part of the expansion of the steam occurs while the steam is flowing through the passages of the rotating wheels. The steam thus acquires additional velocity while it is passing through these wheels, so that as it leaves the vanes there is a reaction which gives a rotary motion to the wheel. No purely reactional wheels have been successful; they always combine the impulse principle with the reaction principle. In a turbine like the Parsons, for example, the steam acts the same as in an impulse turbine when it strikes the rotating vanes, and when it leaves the vanes it acts upon the reaction principle.

In impulse wheels there have been two principal methods used for reducing the rotative velocity of the wheels. In the Curtis turbine steam impinges against the blades of the first wheel, which latter turns at a lower speed than called for by the velocity of the steam. The energy of the steam, therefore, is not entirely utilized, and it leaves this wheel with a high residual velocity, part of which is again absorbed by a second wheel. The steam in turn acts upon a third wheel, and so on. This is the construction used in the earlier types of Curtis turbine, in which there were two sets of four wheels, each set being inclosed in a separate chamber.

In the Rateau and Zoelly turbines there is a succession of chambers with only one rotative wheel in each chamber. Each of these wheels acts like a single De Laval wheel, there being rows of nozzles which direct the jets of steam against its blades. Inasmuch as there are several chambers, however, the drop in pressure between the succeeding ones is comparatively small, so that the velocity of steam is much less than where the total expansion occurs all at once.

In a paper presented before the Chicago meeting of the American Society of Mechanical Engineers Prof. Rateau, of Paris, was inclined to "rub it into" the manufacturers of the Curtis turbine, by contending that they would finally give up their method of construction and adopt the Rateau turbine. Whether this will finally come about we, of course, cannot say, but the trend is in that direction. When steam is given a high initial velocity by flowing through an expanding nozzle and this velocity is absorbed by a series of wheels in succession, there is a great deal of dissipated energy due to the fact that the jet of steam breaks up and does not flow through the wheels in a solid stream. It seems to diffuse, to a greater or less extent, and much of the energy is lost by eddy currents and friction.

Two recent patents taken out by the General Electric Company are significant, in view of Prof. Rateau's remarks. One is upon a turbine in which the number of rotating wheels in each compartment is reduced to two; the other is upon a turbine in which there is only one rotating wheel in a compartment, just as in the Rateau and Zoelly types. Of course the latter patent is essentially a construction patent, since the principle is not new. It looks very much as though turbine construction were resolving itself into three standard types of machines: First, the De Laval type, in which speed reduction is secured by gearing; second, the Parsons or compound reaction type, and third, the Rateau or compound impulse type having but one rotating wheel in each compartment.

* * *

NOT AS RICH AS WE SEEM.

What sort of nabobs are Americans considered to be? Occasionally we are approached in this office by some foreign gentleman who has come to this country to dispose of "valuable patents" and who expects us to tell him what wires to pull and incidentally accept a liberal commission in case a sale is effected. Unfortunately for us, we have not yet been able to participate in profits of this description. It is somewhat out of our line.

Not long ago a representative wished to dispose of a patent on a type of milling cutter. The price was, as we remember it, $25,000, with 10 per cent. in it for us. He probably had a clear patent, so far as any investigation of records could show; but who doubts that many tool makers may have devised and used similar cutters in commercial work and who would pay a high price for a patent in the face of such a probability?

Another instance is the case of a refrigerating machine for domestic and hotel use. We saw an item about it, investigated in the hope of securing something interesting for our readers, and found incidentally that the American rights were for sale at the modest price of $400,000. In our opinion the patents do not introduce any new principle, but are merely construction patents, and combine old ideas in a new form.

Again, we have been visited by a promoter from abroad who controls a patent on a machine shop operation that has heretofore been performed by hand. He has a machine which does the work automatically by power and thus applies a new principle to accomplish a specific purpose. His patent, however, contains no broad claim. It tells in detail what elements enter into the machine and each claim mentions the several elements. There was evidently a chance for a broad claim. stating merely the principle and its application; but it was not made, and as the patent stands there are a dozen ways to get around it. Yet with this imperfect patent the promoter expected to get $350,000 for the invention. He has been advised to consult a patent lawyer before attempting to collect the cash, however. Should it be possible to take out another patent on the device, covering its basic principle, which we question, it will probably be a salable invention; but we doubt its bringing over one-tenth of $350,000.

It is in view of such instances as these that we ask, What sort of nabobs are Americans considered to be?

* * *

One of the interesting exhibits in the Palace of Electricity at the St. Louis Purchase Exposition is a small transformer of 20 kilowatts capacity, working at an electrical pressure of 500,000 volts. With this enormous voltage the discharge between the terminals occurs through the maximum distance of 32 inches. While the machine is of a very spectacular nature and one well calculated to attract the curiosity of the ordinary sightseer, it is also of great interest to the electrical profession, giving, as it does, ocular proof that the limits of high-pressure power transmission lie not in the power station, but rather with the line outside.

A peculiarity of many photographs of automobiles running at very high speed, is that the wheels are apparently distorted to an elliptical shape with the top inclined forward. As such a distortion is obviously a mechanical impossibility it is interesting to know the cause for the change from the true shape in the photograph. The explanation of the phenomenon, it appears, is that most cameras used for taking high-speed pictures, use the focal plane shutter, a device consisting essentially of a curtain immediately over the plate which contains a narrow horizontal slit. As this slit travels downward over the plate the exposure is made progressively and not simultaneously. Hence, owing to the inversion of the image due to the lens, the lower portions of the wheels are exposed first and by the time the slit has traversed the plate so that the image of the upper parts of the wheels is impressed thereon, they have traveled perceptibly forward. This in connection with the angular view gives the peculiar inclined elliptical shape.

* * *

PROPOSED REVISION OF THE PATENT LAWS.

It is a matter of common knowledge that small unimportant improvements generally pay greater returns to their inventors than the great epoch-making inventions that work a revolution in any industry. One reason for it is that by the time the tide has turned so as to fill the inventor's pockets his patents have expired and the public may use his invention without royalty. A case in point is the Parsons steam turbine, the first patents on which expired last year. The world at large is just awakening to the possibilities in the steam turbine and its advantages over the reciprocating piston system; hence the not unnatural bitterness of the inventor over what he considers to be an unjust feature of the patent laws of Great Britain and other countries. In a recent address delivered by Mr. Parsons before the Engineering Section of the British Association he strongly advocated changes in the patent laws of all countries, especially in regard to the time limit. He pointed out that the development of any great scheme centering on a valuable patent, would be impossible if this development required a period equal to or in excess of the present life of patents. Capital could not be induced to invest in what must necessarily prove a losing game. As a solution of the problem Mr. Parsons suggested the formation of an international committee composed of members from all the countries having patent laws, and that this committee should have control of the life privileges of all patents. The inference is that inventors who have been unable to bring their inventions into general recognition and have not reaped a satisfactory reward, should at the pleasure of the international committee be given an extension of their patents as a reward of genius and to stimulate the development of inventions that require a long period of exploitation.

The full text of Mr. Parsons' address is not at hand so that criticism of his scheme must be based upon the more or less uncertain newspaper report, but the general idea, it seems to us, is unpractical if not dangerous. When we remember the abuses and shady transactions growing out of re-issues and extensions of patents in this country, now happily discontinued, we are in no hurry to give an international committee the power of extending privileges of enormous value for the whole civilized world. Such a committee, no matter how conscientious and upright its members, could not help being moved by the persuasion and arguments which great interests would bring to bear upon them. In general if a company which has developed an invention to a commercial state during the life of its patent, has not acquired momentum sufficient to enable it to compete with all comers, something must be wrong in its business methods, and it savors too much of paternalism to ask a government to put a premium on business incompetency. With the development of large corporations, also, has come the possibility of perfecting and marketing an invention in a much shorter time than when this had to be accomplished entirely by individuals or small concerns. This is not inferring, however, that there are not individual cases where an extension of patent privileges would be no more than justice, but patent laws must be made for general conditions and not for specific cases.

THE MINNESOTA.

Announcement is made of the completion of the *Minnesota*, one of the two sister ships built by the Eastern Shipbuilding Co., New London, Conn., for the Great Northern Steamship Co., Mr. James J. Hill's line across the Pacific. The other ship, the *Dakota*, is still under construction The Eastern Shipbuilding Co. was organized and the plant equipped for the purpose of building these two ships, which are the largest American-built vessels yet constructed. The *Manchuria*, built at Newport News for the Pacific trade, had heretofore been the largest American vessel, but the *Minnesota* exceeds her in displacement by about 6,500 tons. When fully laden with cargo and stores the displacement of the *Minnesota* reaches 33,000 tons. Other dimensions are: Length over all, about 630 feet; breadth, extreme, $73\frac{1}{2}$ feet, and depth from the bottom of the keel to the upper navigating bridge, 88 feet $3\frac{3}{4}$ inches- the height of an ordinary ten-story building. As a matter of course the vessel is of massive construction to withstand the enormous strains to which its hull will be subjected. The stern post alone weight 55 tons.

The passenger accommodations are commodious and planned to make the fifteen-day trip across the Pacific a voyage of pleasure. First-cabin passengers have accommodations in a large deck house amidships. Practically all state rooms have outside windows and many of them are arranged en suite, with bath rooms attached. There are the usual library, boudoir, smoking room, etc., and the children have been provided for by an attractively-furnished nursery or play room. The total accommodations are for 218 first and 68 third cabin passengers, while below deck provision is made for carrying thirteen hundred troops or twenty-four hundred steerage passengers. Large and well-equipped toilet and wash rooms are provided for the steerage, also separate galley and pantry.

Four large evaporators for changing salt water to fresh are located in the engine room, furnishing abundance of fresh water to the boilers and for the passengers, should the fresh water carried in tanks give out. These evaporators have a combined capacity of about thirty thousand gallons of fresh water per day. The electric lighting plant is very extensive, as electricity is used for not only lighting all parts of the vessel, but for heating the state rooms, running numerous ventilating fans and supplying power to steer the vessel and operate the cargo hoisting machines.

The ship is driven by twin-screw triple-expansion engines of about 10,000 horse power furnished with steam at 250 pounds pressure by water-tube boilers of the Niclausse type. Each engine is located in a separate water-tight compartment, and the boilers are also divided into two similar compartments, accessible one to the other through small water-tight doors.

The anchors each weigh $8\frac{1}{2}$ tons and the anchor chain, which weighs over 80 tons, is the heaviest ever built. The full equipment of life-saving appliances as prescribed by the United States government is carried on board, and for putting out flames a patent fire-extinguishing system is installed, by means of which any compartment of the ship may be immediately filled with a gas in which a fire cannot possibly burn. For handling the cargo in and out of the numerous hatches thirty-two electric winches are placed on the deck, for while the *Minnesota* is to be classed as a passenger ship, she is intended primarily to carry enormous cargoes of freight across the Pacific.

* * *

THE DATA SHEET FOR SEPTEMBER.

The data sheet for this number deals with the proportioning of the arms, hubs, faces, etc., of gear wheels, such as are used particularly in mill work and heavy machine construction. This sheet is one of several that have been contributed by W. O. Renkin, Valley Park, Mo. For several years Mr. Renkin was in charge of the toothed gear work at the Union Foundry and Machine Co., Pittsburg, Pa. He has traveled extensively, selling and designing gears for all kinds of service, and has accumulated much tabular matter on the subject which is now given for the benefit of our readers.

VARIABLE SPEED MOTORS.—6.

THE C. & C. ELECTRIC COMPANY'S SERIES PARALLEL SYSTEM.

WILLIAM BAXTER, JR.

This system was designed specially for the operation of large printing presses, and is not recommended for use in connection with small machine tools. It has been applied very successfully for driving large grinding and polishing machinery and is specially applicable to all cases where a strong starting torque with quick and even acceleration is required and with such a degree of speed variation, at the higher velocities, as can be obtained by field regulation.

The system is used in connection with a compound wound motor that is provided with two distinct armature windings, each one being connected with an independent commutator. In starting, the two armature windings are connected in series, by properly connecting the commutator brushes, and the velocity is gradually increased by cutting out the starting resistance in the armature circuit, and after this the series field coils, these being cut out in two or more steps so as to properly graduate the acceleration of velocity. To increase the speed beyond this point the two armature windings are connected in parallel, and an amount of resistance is cut into the armature circuit that is sufficient to prevent violent acceleration. This resistance is then cut out gradually and the full running speed is attained. To increase the speed beyond this point resistance is cut into the shunt field circuit until the velocity is increased fifty per cent. or more, as may be required.

From the foregoing it will be seen that in starting, a very strong torque is obtained with a comparatively small current, from the fact that both the armature windings are connected in series, and for the same reason the velocity is very low. The two armature windings are alike, so that when they are connected in series, the velocity is one-half as great as when they are connected in parallel. By means of the armature resistance, and the series field coils many different speeds can be obtained between the starting velocity and that obtained when the armature windings are connected in parallel; but, as has been explained in previous articles, variations produced by means of resistance in the armature circuit cannot be used with satisfactory results except in cases where the load is constant, or nearly so. Speeds obtained above the series parallel velocity can be used whether the load is variable or not as they are produced by introducing resistance in the shunt field circuit.

The Controller for the Series Parallel System.

The controller used with this system is illustrated diagrammatically in Fig. 1. It consists of two electro-magnetic switches that are actuated by the movement of a hand-operated controller, and this latter also affects the necessary circuit combinations to cut resistance in and out of the armature and the field circuits. The magnetic switches are for the purpose of making the changes in the connections that are required to change the armature windings from series to parallel. Fig. 2 is an elevation that shows the relative position of the motor and the controller when applied to a large printing press. Figs. 3 and 4 show in detail the main controller. Fig. 5 is a more complete detail of the front of the controller, showing the various contacts. Figs. 6 and 7 show the front and back of the magnetic switches, with the various details of construction. Figs. 8 and 9 are photographic views of one of these switches. Fig. 10 is a photographic view of the front of the main controller.

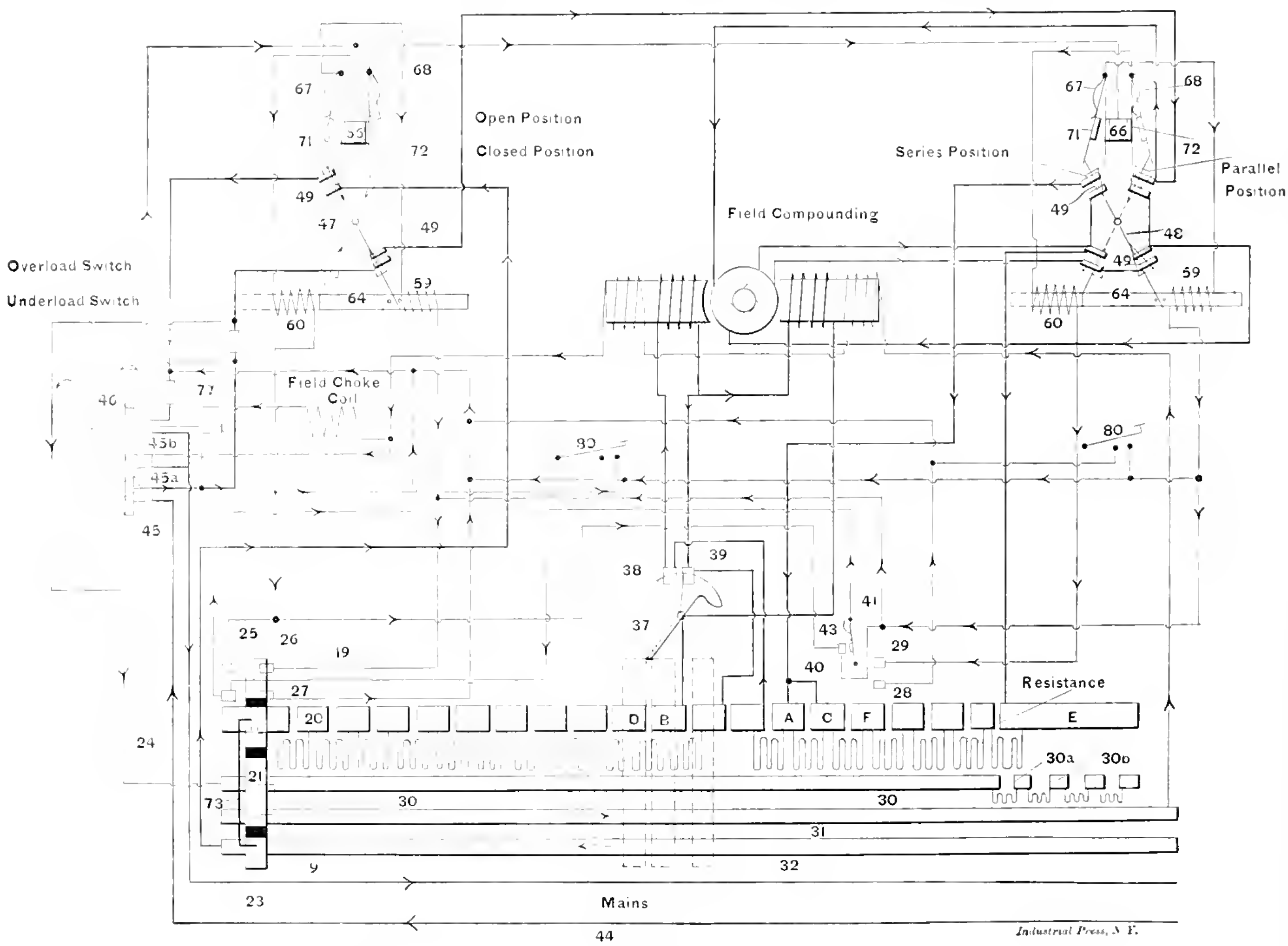


Fig. 1. Controller for Series Parallel System, C. & C. Electric Company.

Referring to Fig. 2, 1 represents the frame of a printing press, 2 is the floor line, 3 is the motor, 4 is the gearing through which the motor drives the press, 8 is the main controller which is provided with a number of contacts disposed in circular form, as shown in Fig. 5, over which swings the lever 9. This lever is rotated by means of a segment 11, which meshes into a gear mounted upon the shaft 10 around which 9 rotates. The segment 11 is actuated by the connecting rod 16 attached to the slotted end 15 of the hand lever 12, the latter

being mounted to swing around the stud 13. The position of the magnetic switches is shown at 47, and at *SB* is located a switchboard.

The Main Controller.

The main controller is shown clearly in Figs. 3, 4 and 5. The lever 9 carries contacts 19, 20, 21 and 23. Contact 19 connects with the stationary contacts 24, 25, 26, 27, 28 and 29 (See Fig. 5). Contact 20 connects with the circular row of contacts 8,

pin 63 at one end, that passes into a slot in the core 64 of the magnets. To throw the switch lever 47 more power is required at the beginning of the movement than at the end, owing to the fact that the friction of the blades 49 against the stationary contacts has to be overcome. To increase the initial pull of the magnets, auxiliary cores are provided as shown in Fig. 6, and these are made movable. In addition a slot 65 is made in the main core, so that when it moves it strikes a

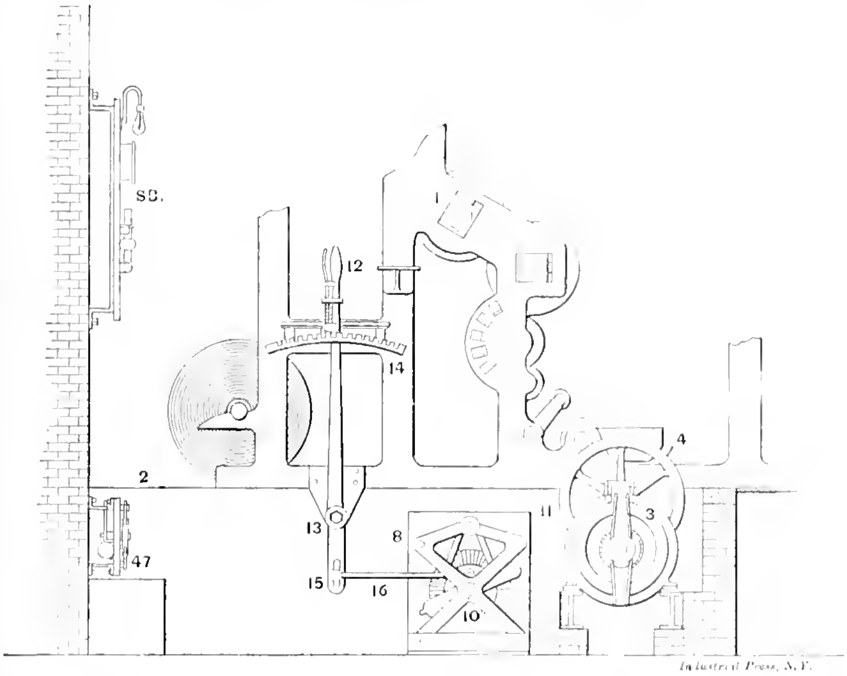


Fig. 2. Elevation showing Relative Position of Motor and Controller.

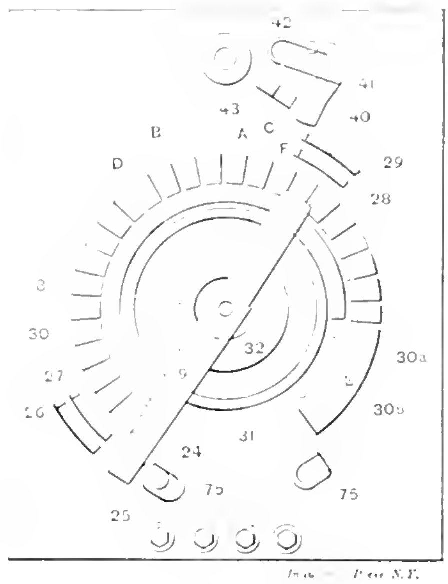
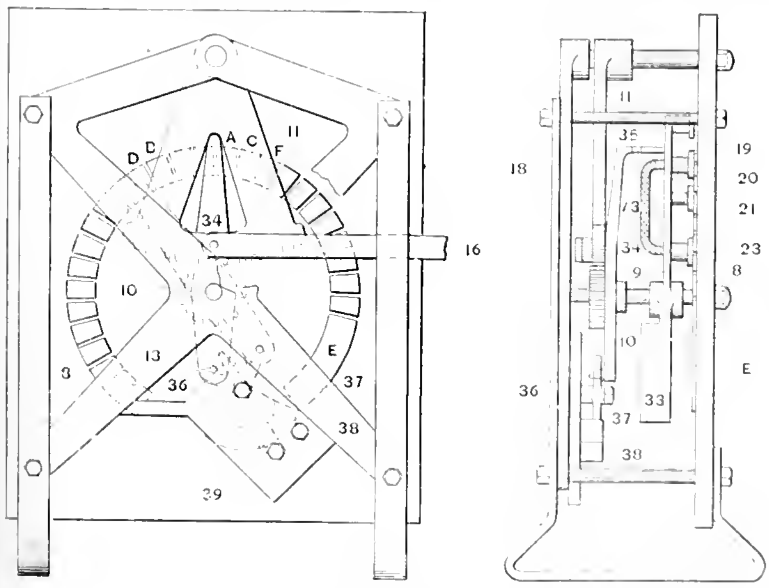


Fig. 5. Detail of Front of Controller

Contact 21 connects with stationary contact strips 30 and 31, and contact 23 connects with stationary strip 32. A second lever 34 is secured to shaft 10 and is provided with a pin 36 that engages with the forked end of a small switch 37 which swings over and connects contacts 38 and 39. Lever 9 in rotating forward strikes a pin 40 mounted upon a switch 41 that is spring-supported and pushes the same to the right. On the backward movement 9 strikes this pin again and moves con-

blow against the pin 63 and thus dislodges the blades 49 from the stationary contacts. The auxiliary cores, being movable are knocked out of the way by the main core, hence a long movement of the latter core is obtained with a comparatively short distance, or air gap, between it and the auxiliary cores; the result being that the strength of the magnet is greatly increased during the first part of its movement. The momentum of lever 47 and the other moving parts is sufficient to carry it over into engagement with the opposite set of stationary contacts, after the solenoid magnet gives it the initial movement, and on that account means are provided to automatically open the circuit of the solenoid soon after the switch lever has moved. The stationary contact 66, Fig. 6, and the switches



Figs. 3 and 4 Details of Main Controller.

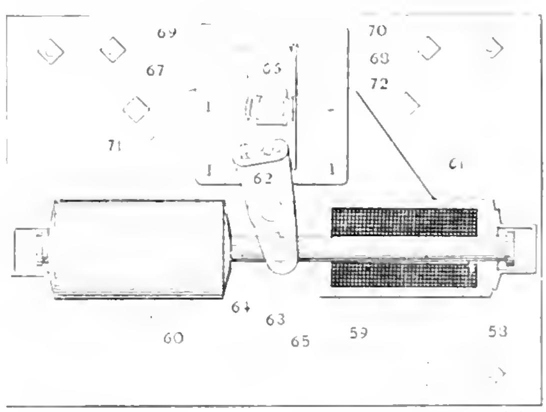


Fig. 6 Diagram showing Rear of Magnetic Switch.

tact 41 over contact 43, for a purpose that will be hereafter explained. Contacts 20 and 23 are connected by the cable 73.

The Electro-magnetic Switches.

In Fig. 7 the switch lever 47 and 48 is actuated by the solenoids 59 and 60 shown in Fig. 6. The blades 49 are insulated from the lever. The solenoids shown in Fig. 6 are mounted on one side of a slate slab, and the switch lever 47 and the stationary contacts with which it engages are mounted on the other, the shaft 61 passing through the slab. On the solenoid side of the slab the shaft 61 carries a lever 62 provided with a

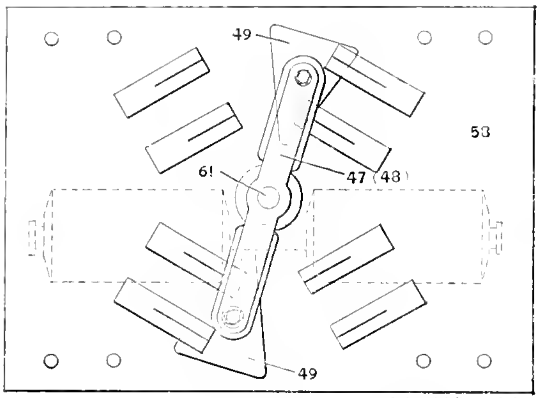
67 and 68 are for this purpose, and the manner in which they are actuated by lever 62 can be clearly understood. The solenoid magnets are energized when lever 9, Fig. 5, bridges either one of the pairs of contacts, 26, 27 or 28, 29.

Operation of the Series Parallel Controller.

From the foregoing explanations of the construction of the several switches the operation of the controller as illustrated in diagram Fig. 1 can be readily understood. To make this diagram as clear as possible the controller, Fig. 5, has been represented at the bottom of the diagram with the stationary

contacts rolled out into straight strips, and lever 9 is shown as a bar in the vertical position, at the left of the diagram. In addition, all the parts in Fig. 1 have been numbered the same as in the other illustrations.

The current enters through the mains 44, passes to switch 45, and thence through an overload switch to one terminal of the shunt field and to magnet switch 47, which is shown in the closed position by full lines and in the open position by dotted lines. When lever 9 is moved from the position shown in Fig. 5 to that of Fig. 1, block 19 bridges contacts 26, 27 and a circuit is closed through the arm then in contact with 66, down through solenoid 59 to contact 26 and thus to the main line.



Industrial Press, N.Y.

Fig. 7. Front View of Magnetic Switch.

Solenoid 59 being energized will throw 47 to the closed position shown in full lines. The current will then pass through blade 49, lower end of 47 to upper right side of 48 and thence through one armature winding to lower right side contact of 48 and thence through the other armature winding back to 48 and on to contact *A* of main controller. From this point it passes through a resistance coil to the contact at the left and thence through the series field coils to contact *B* from where it passes back to main 44 through lever 9 and switch blade 46. It will be noticed from the connections through the solenoid 59 of switch 48, that if the lever should happen to be in the parallel position it will be thrown over to the series position.

As lever 9 advances it cuts out the armature resistance, until it reaches contact *D* when it strikes lever 37 and cuts out one-half of the series field coils, by connecting *B* with 39. The further movement of 9 connects 38 and 39 with *B*, thus cutting

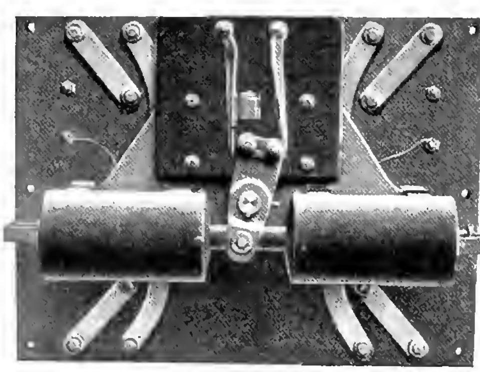


Fig. 8 Half-tone View of Fig. 6.

out all the series field. Advancing further, lever 9 connects contacts 28 and 29 and thus closes the circuit through solenoid 60 of switch 48, thereby drawing the core to the left and throwing the switch into the position shown in dotted lines. This change connects the armature windings in parallel, the armature circuit passing to the end contact *E* thus cutting into this circuit the resistances interposed between *E* and *F*. The further advance of lever 9 cuts out this resistance and finally cuts into the shunt field circuit the resistances interposed between the contacts 30a, 30b, etc.

In moving lever 9 back to the starting position it first cuts out the shunt field resistance, then cuts in the armature resistance and when it reaches pin 40 it carries contact 41 over onto 43, thereby closing the circuit through solenoid 59 of switch 48, thus opening the armature circuit and at the same time connecting the armature windings in series. Moving further to the left lever 9 will strike switch 37 and throw it off the contacts 38, 39. When 9 reaches the starting position, shown in full lines at the left, it will close the circuit through solenoid 59 of switch 47 and thus again close the armature circuit with the windings in series.

From the foregoing explanation of the action of the controller, on the return motion, it will be seen that if it is desired to stop the motor, lever 9 is returned quickly to the starting position; if it is desired to reduce the speed to a point not slower than is obtained with the armature windings in the parallel connection, the lever is moved back slowly to this

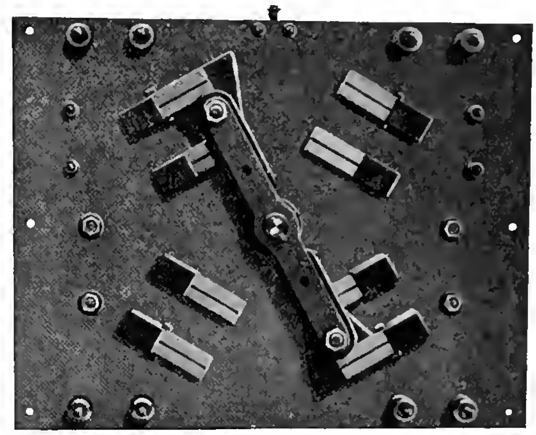


Fig. 9. Half-tone View of Fig. 7.

point; but if a still slower speed is desired, the lever is moved back to the starting position and is at once advanced until it meets the speed to which the motor has slowed down. If this speed is still too high, the lever is moved back step by step until the desired velocity is reached.

The switches 80 shown in Fig. 1 are emergency switches which can be located in any place from which it may be desired to stop the motor.

The hand switch 45 has its blades so arranged that when it is opened a spring-actuated switch 77 closes a circuit around the shunt field coils. This circuit includes a choke coil and thus the danger of puncturing the insulation of the shunt field coils by opening the circuit is obviated.

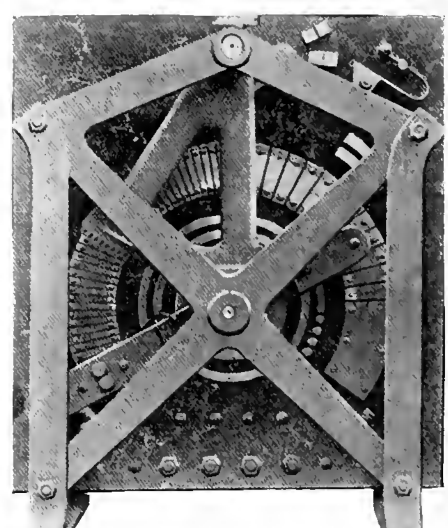


Fig. 10. Front View of Main Controller.

The electro-magnetic switches 47 and 48 can be located in any convenient position, as they are connected with the main controller through circuit wires only; but the main controller itself, must be so located that the lever 9 may be moved by means of a connection with a hand lever, as is clearly shown in Fig. 2. When the controller can be placed within easy reach of the man that operates the machine driven by the motor, the hand lever can be replaced by a wheel mounted directly upon the end of shaft 10, as is shown in Fig. 11 which illustrates a motor with the whole controlling apparatus mounted upon its back.

BEAMS AND PLANES WITH SEVERAL SUPPORTS.

Editor MACHINERY:

Some of the points in Mr. Blake's article on "Problems In Beams and Planes Severally Supported and Eccentrically Loaded," in the July number of MACHINERY, do not seem to conform to the theory of flexure of beams. Referring to Fig. 2 of his article, if the beam is supported at y and loads placed at A, B, and C, whose values are determined according to his formula, the beam will be in equilibrium, but it does not follow that the load W will produce reactions of the same magnitude at these points. If the beam were perfectly rigid and the points A, B and C would yield in proportion to the reaction brought upon them by the beam, then his formula would give the reactions; but the beam is not rigid, neither are the points A, B and C. Nor do they necessarily yield in the same proportion. It is then evident that the reactions at A, B and C depend upon the stiffness of the beam and the rigidity of the points of reaction, as well as their location.

The following simple experiment will give a practical proof of the foregoing. Place a thin yard stick so that its broad side bears for about four inches on the under side of a table leaf and arrange a support near the middle of the stick, as shown by full lines in Fig. a. A load, well within the strength of the stick, placed at the outer end will bend the stick so that the extreme end under the table leaf leaves its support entirely, and the edge of the table leaf takes the whole reaction, as shown by the dotted lines of Fig. a.

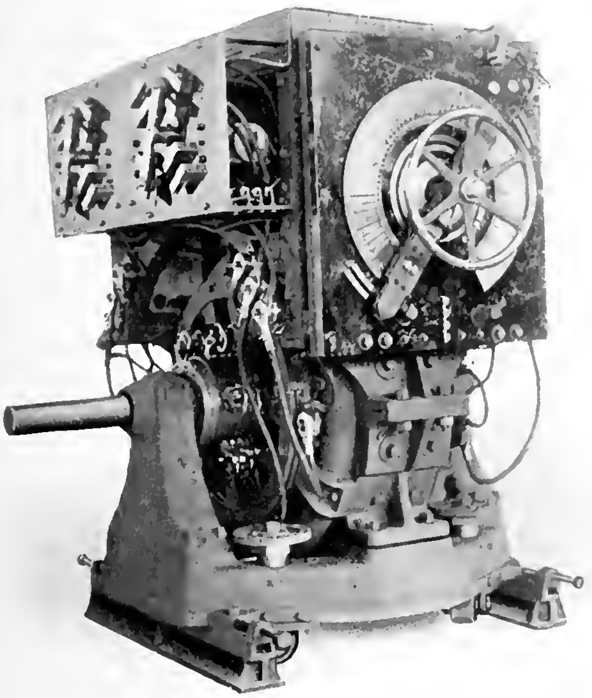


Fig. 11. Showing a Motor with all the Controlling Apparatus in Place. (See previous page).

Beams having more than two supports, as Figs. 2, 3 and 4 of Mr. Blake's article, are termed continuous beams, and the reactions at the supports depend upon the elastic curves of the beams. In other words, the bending of a beam which has more than two supports influences the reactions which occur at the supports. The imperfect adjustment or the sagging of a support of a continuous beam may cause stresses far in excess of those for which the beam was designed, and thus offset the theoretical advantage which a continuous beam has over a simple beam. The same reasoning as was applied to beams will lead to the conclusion that when planes have more than three supports the flexure influences the reactions. In the case of the four-armed spider, shown by Fig. 8 of Mr. Blake's article, if we take moments about rectangular axes we find it is not in equilibrium with the reactions as given.

The load and the reactions necessarily form a balanced system. Only three points are required to support a plane. If more are used the division of the load is arbitrary, provided the conditions of equilibrium are filled. In the following the load is divided in inverse proportion to the lengths of the arms taking $O\ A$ and $O\ C$ together and $O\ B$ and $O\ D$ together.

$$\text{Then } A + C = \frac{O\,B + O\,D}{(O\,B + O\,D) + (O\,A + O\,C)} \times 1000 = 488.37$$

$$\text{But } (A + C) + (B + D) = 1000 \qquad (1)$$

$$\therefore B + D = 511.63$$

The letters A, B, C and D in these equations represent the reactions at those points. It now remains to so proportion the sums of A and C and B and D that the system will be in equilibrium. Equation (1) and the following (2) and (3) express the conditions of equilibrium.

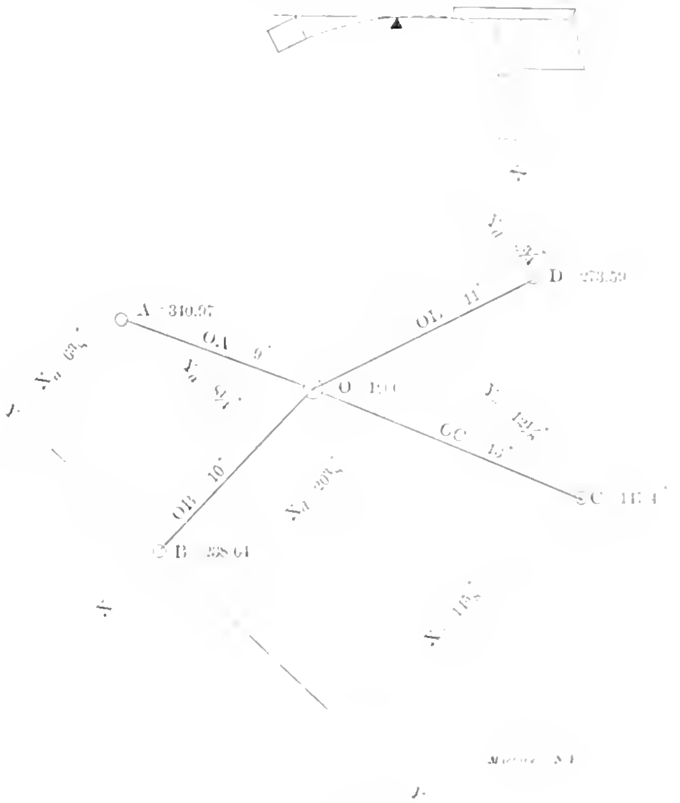
$$A\,X_a + B\,X_b + C\,X_c + D\,X_d - O\,X = 0 \qquad (2)$$

$$A\,Y_a + B\,Y_b + C\,Y_c + D\,Y_d - O\,Y = 0 \qquad (3)$$

The subscripts of X and Y indicate the point of which they are the co-ordinates, as is shown in Fig $8a$, which is the same as Fig. 8 of Mr. Blake's article with the co-ordinates added. Assume the erigin at B and let $O\ B$ be the X axis, then X_b, Y_b and Y_o are each $= 0$. Substituting in equations (2) and (3) the values of X and Y from Fig. $8a$, we have

$$6\tfrac{3}{8}\,A + 11\tfrac{1}{8}\,C + 20\tfrac{3}{8}\,D = 10 \times 1000 \qquad (2a)$$

$$8\tfrac{1}{4}\,A - 12\tfrac{1}{8}\,C - 3\tfrac{3}{4}\,D = 0 \qquad (3a)$$



Figs. a and 8a.

from which the values of the reactions are found to be as follows:

$$A = 340.97$$
$$B = 238.04$$
$$C = 147.40$$
$$D = 273.59$$

Consequently the arms should be proportioned for these loads.

The method of proportioning the arms now needs attention Since point O is common to all the arms, the deflection for all must be the same. Then, assuming that the maximum fiber stress is to be the same in all arms, it is necessary to design each arm so that its reaction will deflect it the same as the other arms are deflected by their reactions and at the same time produce the same maximum stress as in the other arms. Consider the two arms $O\ A$ and $O\ B$. The deflection of $O\ A$ under load A for uniform section of arm is

$$F_a = \frac{1}{3}\,\frac{(O\,A)^3 \times A}{E \times I_a} \qquad (4)$$

and of $O\ B$ under load B is

$$F_b = \frac{1}{3}\,\frac{(O\,B)^3 \times B}{E \times I_b} \qquad (5)$$

also

$$I_a = \frac{A \times (O\,A) \times e_a}{f} \qquad (6)$$

$$I_b = \frac{B \times (O\,B) \times e_b}{f} \qquad (7)$$

In which f = maximum fibre stress.

e = distance of extreme fibre from neutral axis of section.

E = modulus of elasticity.

I_a and I_b = moments of inertia of cross sections of arms $O\,A$ and $O\,B$ respectively.

Substituting the values of I_a and I_b from equations (6) and (7) in equations (4) and (5) we have

$$F_a = \frac{(O\,A)^3 \times A}{3\,E \times \dfrac{A \times (O\,A) \times e_a}{f}} = \frac{(O\,A)^2 \times f}{3\,E \times e_a} \qquad (4a)$$

$$F_b = \frac{(O\,B)^3 \times B}{3\,E \times \dfrac{B \times (O\,B) \times e_b}{f}} = \frac{(O\,B)^2 \times f}{3\,E \times e_b} \qquad (5a)$$

But these deflections are equal, hence

$$\frac{(O\,A)^2 \times f}{3\,E \times e_a} = \frac{(O\,B)^2 \times f}{3\,E \times e_b} \qquad (8)$$

Remembering that f is the same in all arms we have

$$\frac{e_a}{e_b} = \frac{(O\,A)^2}{(O\,B)^2}$$

Hence the depths of the arms should be proportional to the squares of their lengths and the moments of inertia of the cross sections should be of such value that the desired fiber stress is secured.

If the depths of the arms are to be the same where they join each other, then equation (8) becomes

$$\frac{(O\,A)^2 \times f_a}{3\,E \times e} = \frac{(O\,B)^2 \times f_b}{3\,E \times e} \qquad (8a)$$

Since e is now to be made the same, we have from (8a)

$$\frac{f_a}{f_b} = \frac{(O\,B)^2}{(O\,A)^2} \qquad (8b)$$

It is seen from this that the moments of inertia of the sections should be such that the maximum fiber stresses are in inverse proportion to the squares of the lengths of the arms. If the arms are made of uniform strength throughout their length instead of uniform section, the same results are reached by similar reasoning. E. E. GRAHAM.

Cleveland, Ohio.

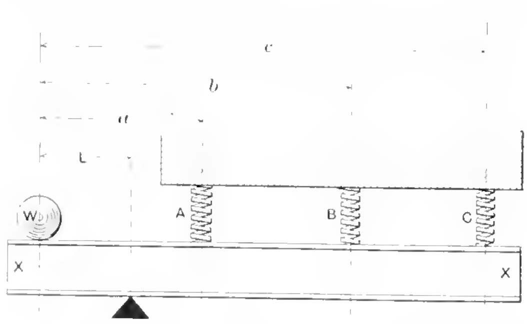
* * *

A CRITICISM.

Editor MACHINERY:

The writer is of the opinion that an erroneous idea is conveyed in the article on beams and planes severally loaded and supported, appearing in the July issue of MACHINERY.

For formulas 6, 7 and 8, in reference to Fig. 2 of the article, to be applicable one must assume the beam to be perfectly rigid, and the reactions as being uniformly elastic.



Since elasticity is one of the universal properties of matter—*i.e.*, all beams deflect—this is an impossible condition. Fig. 1 illustrates a close approach to these conditions.

If the beam XX be loaded to a fractional part of its ultimate strength, thus reducing flexure to an inconsiderate factor, and the reactions A, B and C be produced by springs of equal strength and elasticity, the distortion of the springs, *i.e.*, the amount compressed or elongated, would be proportional to their distance from the point of rotation y. Since stress is proportional to strain within the elastic limits the force at A, B and C would also be proportional to their respective distances from the point y. Now, since the magnitude of each force, and its moment, are both proportional to its distance from the point of rotation, it follows that its moment, or torque, is proportional to *the square* of this distance; hence torque due to spring

$$\left.\begin{aligned} A &= \frac{a^2}{a^2 + b^2 + c^2} \\ B &= \frac{b^2}{a^2 + b^2 + c^2} \\ C &= \frac{c^2}{a^2 + b^2 + c^2} \end{aligned}\right\} \text{ of the total torque } W\,L.$$

If the reactions A, B and C be practically rigid in comparison to the beam, the entire load would be concentrated upon A by reason of the beam's deflection.

If the relative elasticities of the beam and the several reactions be known the resulting magnitude of the forces, the consequent moments, strains, etc., may be determined; but in practice such constructions are usually avoided, as inaccuracy of workmanship, unequal settlement or some other practical consideration would usually make the problem indeterminable. Even with theoretical conditions, if one must take into account the elastic curve of the beam, the calculations would become very complicated.

Philadelphia, Pa. JOHN S. MYERS.

* * *

ECCENTRIC LOADING.

FRANK B. KLEINHANS.

The subject of eccentric loading, although treated in a number of text books, is one that is not very clearly understood, and a few illustrations of the application of eccentric loading may be of assistance to the reader. The principle of the eccentric load, as shown in Fig. 1, is that the line of the load P does not coincide with the center line, $c\ c$, along which the reaction is taken up. This load acting at a distance L from the center of gravity of the supporting section produces a bending moment $P \times L$ about this section. At the same time we have also a uniformly distributed load over this section which is equal to P. One other thing which will be noticed is that the bending action is the same for any section $A\ B$, no matter how great or how small D may be.

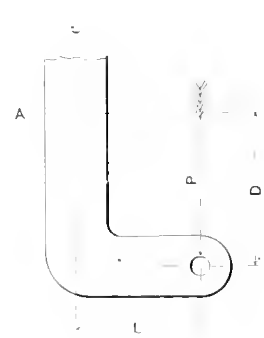


Fig. 1.

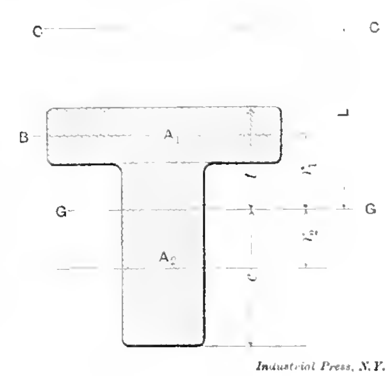


Fig. 3.

Fig. 2 represents a punching machine which must be figured according to this principle of eccentric loading. The size of the gap at A and the load determine the size and shape of the section as the frames for these machines are invariably made of cast iron, and as we cannot use as high a working stress in tension as in compression, it is advisable to make the section as shown in Fig. 3, where the amount of metal is greater on the side nearest the load. We first lay down the section to scale on a piece of heavy paper, then cut it out and balance it on a needle point, thus obtaining the center of gravity of the figure. Then draw a line $G\ G$ through the center of gravity. Now divide the figure into two rectangles A_1 and A_2, the moment of inertia of each one of which about

its center of gravity is 1-12 $B H$, in which B is the width and H is the height of the rectangle. Knowing the moment of inertia of each one of these areas about its axis as shown, we can obtain the moment of inertia about any other axis $G\ G$ thus:

Let A = total area of section,
I = moment of inertia about $G\ G$,
I_1 = moment of inertia of area A_1 about its axis,
I_2 = moment of inertia of area A_2 about its axis.

We then have:

$$I = (I_1 + A_1 r_1^2) + (I_2 + A_2 r_2^2)$$
$$A = A_1 + A_2$$

Let P = the load,
L = the distance from load to centre of gravity,

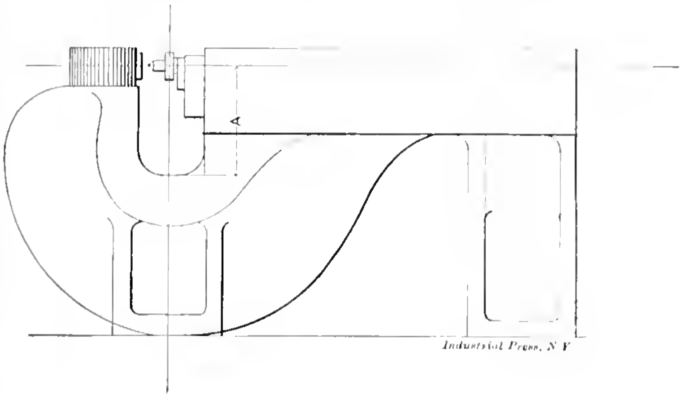


Fig. 2.

S_t = tension stress,
S_c = compression stress.

We then have:

$$S_t = \frac{P}{A} + \frac{P\,L\,t}{I}$$
$$S_c = \frac{P}{A} - \frac{P\,L\,c}{I}$$

In calculating these sections for eccentric loads, St for cast iron should not exceed 4,000 pounds, while Sc may equal 12,000 pounds. In steel castings, St would be taken at 9,000 pounds and Sc at 10,000 pounds.

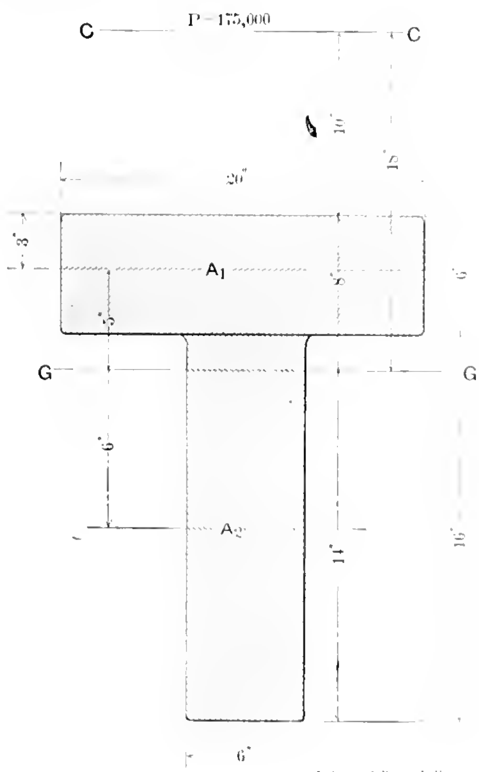


Fig. 4.

In order that the above expressions may be better understood, the following example will be given:

Let Fig. 4 represent a section the strength of which we wish to determine.

We will then have

P = 175,000 pounds
$A_1 = 20 \times 6 = 120$
$A_2 = 16 \times 6 = 96$
$A = A_1 + A_2 = 216$

$$I_1 = \frac{20 \times (6)^3}{12} = 360$$
$$I_2 = \frac{6 \times (16)^3}{12} = 2048$$
$$I = (360 + 120 \times (5^2)) + (2048 + 96 \times (6^2)) = 8864$$
$$S_t = \frac{175,000}{216} + \frac{175,000 \times 18 \times 8}{8864} = 3653 \text{ tension}$$
$$S = \frac{175,000}{216} - \frac{175,000 \times 18 \times 14}{8864} = -4161 \text{ compression}$$

As this section is for cast iron and as both stresses are within the safe working limit, the section will be satisfactory.

If the section was to be made of steel, however, it would have to be shaped like an I-beam in order to keep the stresses from running too high in compression.

A peculiar feature about eccentric loading is that with material like wrought iron, for instance, where the tension and compression should be the same, the section to resist the load cannot be made rectangular, but the tension side must be made heavier and therefore the section assumes more or less the shape of a T-iron. This fact is sometimes lost sight of and we only too frequently have a breakdown.

A cause of such a failure is shown in Fig. 5. This was the upper portion of a hydraulic punch and shear, the hook portions at H being shaped up so as to receive a steel cylinder, which fitted snugly under the flanges. The total pressure of the cylinder was therefore to be resisted by the two hook portions of the frame at H. The capacity of the machine was 100,000 pounds, and using the same notation as before, we have:

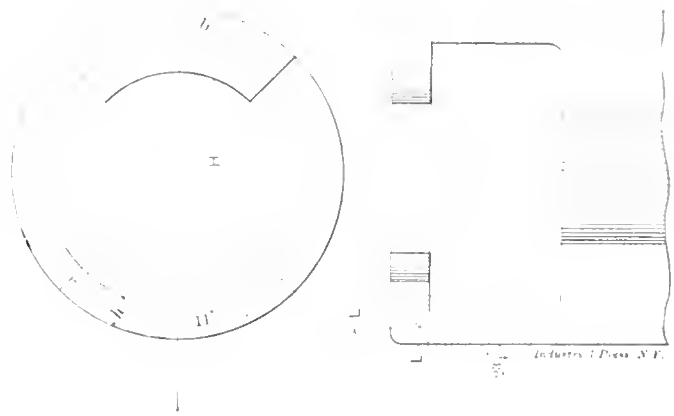


Fig. 5.

$$S_t = \frac{P}{A} + \frac{P\,L\,t}{I} \text{ in which}$$
$$I = \frac{b\,h^2}{6} \quad \text{We then have}$$
$$S_t = \frac{100,000}{2\frac{3}{4} \times 11 \times 2} + \frac{100,000 \times 2 \times 1\frac{1}{2}}{\frac{2 \times 11 \times (1\frac{1}{2})^2}{6}}$$
$$= 1,600 + 10,000$$
$$= 11,600 \text{ pounds stress in tension.}$$

This should not have exceeded 4,000 pounds fiber stress and we can readily see why it was that these hook portions failed at the first application of pressure.

It is surprising to note where the action of eccentric loading comes in; in fact, a uniformly-distributed load being very rare in the members of any machine. We should, therefore, trace out the manner in which the stresses act and make proper calculations for those cases where eccentric loading occurs.

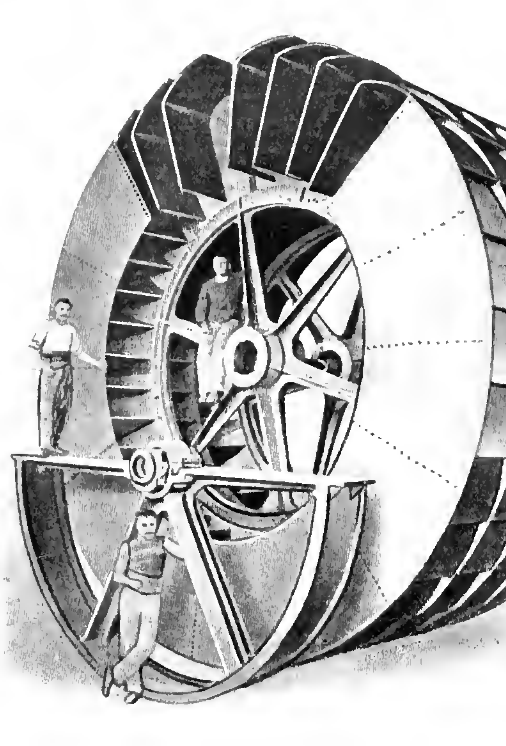
THE VENTILATOR OF THE ALBESPEYRE TUNNEL.

DR. ALFRED GRADENWITZ.

At a recent meeting of the Society for the Encouragement of National Industry, Paris, Mr. E. Denis-Farcot, Plaine St. Denis, France, read a communication on the ventilation scheme employed by him in connection with the Albespeyre tunnel.

This tunnel, situated on the Langogne-Alais line, of the Paris-Lyons-Mediterranean Co., traverses the parting of water between the Atlantic and the Mediterranean. It is a single-track tunnel, 24 square meters in cross section, 1,503 meters in length; its mean gradient is about 25 millimeters per meter.

The ventilation of the tunnel, which is traversed by rather numerous and heavy trains, presented special difficulties. The natural ventilation, being frequently opposed by violent winds, was found inefficient, and three vertical shafts, each one square meter in cross section, and 60, 120 and 150 meters in depth respectively, were sunk into the tunnel, but these afforded practically no relief. In the beginning, the trains going up grade would be pushed by an auxiliary engine placed at the rear of the train. As, however, the latter traversed an atmosphere contaminated by the smoke and gases from the engine ahead, the men in charge of the auxiliary



Mammoth Ventilating Fan.

were in serious danger of asphyxiation. So this plan was eventually abandoned, and the train divided into two parts; but as the atmosphere of the tunnel would remain in a contaminated condition for as long sometimes as 40 minutes after the passage of the train, this method did not by any means prove satisfactory.

In order to obviate this drawback, the company decided to install a system of artificial ventilation, and Mr. Farcot was entrusted with the work.

The ventilator fan which he has installed is 6 meters in diameter by 2½ meters in breadth, with vanes bent in a direction opposite to that of the rotation of the wheel, and gives an output of 150 cubic meters of air per second. The fan wheel has 64 sheet-steel vanes and is built in halves. The total weight is 10 tons. It is encased with the lower half enclosed by masonry and the upper half by a sheet-steel cover. The fan operates by induced action and the air issues through a conduit, a cross section of which increases from 9 to 21 square meters.

The fan is driven by a 150-horse-power Corliss engine, at 122 revolutions per minute. Although the speed of the fan is very little above that of the engine a belt drive was preferred to direct coupling, lest the engine obstruct the passage of the air from the fan; and, moreover, it was believed that the low temperature of the air current would seriously affect the economy of the engine.

With an output of 150 cubic meters per second, as measured at the outlet, a mean air movement as high as 7½ meters per second is obtained throughout the tunnel, resulting in a total output of 185 cubic meters, as some of the air entering at the mouth of the tunnel is carried along. This speed, however, inconveniences workmen employed in the tunnel and puts out the torches. A speed of 5 meters per second, corresponding to a total output of 120 cubic meters, is still too great; in fact, three meters should not be exceeded during the time the men are working.

The service is performed as follows: As long as no train going up grade is signalled, the ventilator runs at a low speed, viz., 50 turns per minute. On the approach of a train the speed is raised to 150 revolutions, and maintained for about 8 minutes. Four minutes are required for the passage of a train through the tunnel and an additional four minutes are necessary for clearing out the smoke.

As up-grade trains move in a direction opposite to the air current and at a speed of 25 to 30 kilometers per hour, or 7 to 8 meters per second, the air current is practically stopped during the time the train traverses the tunnel. But as a certain amount of air still surrounds the train, the atmosphere of the tunnel will remain in a condition respirable for the personnel and it has been found possible to again use the rear locomotives. As the atmosphere is renewed after the passage of each train, the front locomotive does not contaminate the air to such an extent as to seriously incommode the crew of the second.

In Mr. Farcot's communication on mechanical ventilation, recently made in Paris on the Metropolitan Railway between the Vincennes and Bastille stations, some further experiments are recorded. A ventilator, 2½ meters in diameter, giving an output of 50 to 60 cubic meters per second and being susceptible both of aspiring and blowing actions, had been installed at Vincennes, with a view to ventilating this tunnel as far as the Bastille, where the tunnel terminates in the open air. As this ventilator was in operation during the hours of service, as soon as the doors of either the Vincennes or the neighboring Nation station opened, there was produced a most violent air current which was absolutely unbearable, whereas the regular air current did not go as far as the Bastille, on account of the frequent passage of trains running in an opposite direction. By night, however, as well as outside of the working hours and whenever the doors of the station were closed, the air current would be established regularly throughout the length of the tunnel, at a speed of 1½ meters per second, corresponding with an output of 10 cubic meters.

* * *

The vitality of some totally unpractical mechanical ideas seems marvelous at first thought, but the probable explanation is the vitality of the inventors who persist in pushing them. "Poleforcia," a scheme for gaining power or, in other words, a perpetual motion machine, had its day in Philadelphia some years ago, and is now troubling the Britons. Another idea equally unpractical from a correct mechanical standpoint, which originated in America and has crossed the Atlantic, is a ball-bearing rifle gun. In this gun the ordinary rifling grooves are replaced by deep grooves in which are placed a multitude of hardened steel balls over which the projectile is supposed to ride without friction as it is discharged from the gun. No space is allowed for the balls to roll so it is difficult to understand the inventor's claim for an anti-friction bearing. The inventor appears to labor under the misapprehension that the chief resistance caused by a projectile to rapid flight is its frictional resistance in the bore, when, as a matter of fact, this resistance is but a small fraction of that due to the inertia of the projectile, in heavy ordnance.

* * *

Four-cycle gasoline engines for motor bicycle use are made that develop one brake horse power for each 20 pounds weight of motor.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The August data sheet erroneously states that watts × 746.00 = horse-power, and that horse-power × 0.00134 = watts. The factors should be transposed so as to read: Watts × 0.00134 = horse-power, and horse-power × 746 = watts.

A correspondent of the *Woodworker* says that a good rust joint mixture is made of ten parts of iron filings (or borings) to three parts of chloride of lime. Mix into a paste with water, apply to joint and clamp together. In twelve hours it will be set solid.

The old New Bedford whalers are mines of copper wealth according to *Marine Engineering*. The timbers were heavy and white oak put together "on honor" which apparently meant the liberal use of copper fastenings. It is said that from $2,000 to $3,000 worth of scrap copper is often realized when one of these old vessels is broken up.

A novelty in time-keeping devices is a handless clock which shows the time in hours and minutes on direct-reading celluloid tablets. These tablets or leaves are arranged in two rows around a vertical cylinder, each leaf being pivoted to the outside of the cylinder, and on the "face" portion of the cylinder they are turned in opposite directions like an open book. As the cylinder turns successive leaves flip over from one side to the other, thus exposing the successive figures denoting the hours and minutes.

In a recent interview Mr. Charles M. Schwab, the former president of the United States Steel Corporation, said that in 1879 the steel production of this country was 1,000,000 tons per annum; in 1889 it had increased to 7,000,000 tons; and in 1899 it was from 12,500,000 to 15,000,000 tons. The consumption is now 15,000,000 to 16,000,000 tons a year and in ten years will be over 20,000,000 tons. The consumption of steel rails required to replace those worn out is 2,500,000 tons annually, and 600,000 tons are used in the manufacture of steel cars.

The true and, therefore, persistent inventor is satisfied with no device or product; he is continually working out new combinations or changes in the things previously created. Even the humble carpet tack has not been allowed to retain its original concrete form, but in a new shape it assails our eyes, having a double head arranged tandem fashion, one over the other. The true inwardness of this invention is not, as might be imagined, to foil its peculiarly fiendish propensity for standing upright on chair seats or on the floor awaiting the bare foot of the unsuspecting night prowler, but to facilitate its removal from tho floor in spring house cleaning time.

Men get the notion into their heads that you cannot run wood-working machinery fast enough, and speed up their planers and saws to the last limit. This is probably the poorest kind of policy. Saws running above a normal speed will not run as easy or do as good work as at much lower speed. If any one does not think so, let him take a common bench saw, speed it up high and feed it by hand himself. He will soon find that the stock pushes hard. Then he concludes the saw is dull. After filing, he tries it again, with the same result. The trouble is, one cut follows the other too quickly and glazes it over. Every wood-working machine shows the same effect following a too high speed. There is a normal speed for saws and planers.—*Woodworker*.

The liquid condition of petroleum is ordinarily an advantage when considered for fuel purposes, but sometimes it is a decided disadvantage, especially when it is to be used temporarily in coal furnaces or where the conditions are such that the liquid fuel is a grave fire risk. Considerable attention has been given to briquetting petroleum so as to make it available where liquid fuel is not permissible. A recent consular report gives a brief outline of a German process for petroleum briquetting which appears simple and apparently requires practically no machinery. To one quart of petroleum is added soft soap, 150 grains; rosin, 150 grains; and caustic soda lye wash, 300 grains. The mixture is heated and thoroughly agitated. This takes about forty minutes and during this time care must be taken to prevent the liquid running over; this is achieved by adding a little soda. The mixture is poured into briquette molds to solidify and allowed to cool, after which the briquettes are dried in an oven for an hour or two.

NEW GALVANIZING PROCESS.

A new process of galvanizing, known as "Sherardising," has been developed abroad to a commercial basis, which promises to overturn the present hot galvanizing process used on iron and steel. By the new process the work is covered with an even coating of zinc without dipping it into a molten bath, and it is done at considerably less than the melting temperature of zinc so that the deteriorating effect of high temperature is considerably reduced. The work to be galvanized is thoroughly cleared of surface oxide or rust by sand-blasting, acid bath or other preferred means, and is then placed in an air-tight cast iron muffle or oven charged with the zinc dust of commerce. After being kept at a temperature of from 500 to 600 degrees F. for a few hours, the work is removed and allowed to cool. The process of coating with zinc has been perfectly effected during the baking process; the thickness of the coating of zinc depends upon the time the work is kept in the muffle. The galvanizing is thus done at a temperature about 200 degrees less than that necessary by the hot bath process; moreover, it has the advantage of wasting none of the zinc. The waste of zinc by the common process is a quite considerable percentage of the total amount of the bath. Although common bar zinc melts at something over 700 degrees F., the zinc dust of commerce does not melt at an even much higher temperature, so that there is no danger of its melting in the muffle.

THE TELEPHONE PARADOX.

A writer in the New York *Times* explains the "telephone paradox," that is, why the cost of telephone service per subscriber instead of decreasing with an added volume of business, increases at a faster rate than the increase of subscribers.

"The switchboard in the exchange is built in sections, each of which contains on an average the terminals of the lines of 200 incoming subscribers. These terminals are called 'jacks,' and the panel containing them is called the answering panel. In addition to these 200 incoming jacks, each section must contain the outgoing jacks of each subscriber in the exchange. This is necessary in order that the operator in each section may be able to connect any of the incoming subscribers in a section with any other subscriber in the exchange. The panel containing these outgoing jacks is called the multiple panel. On the above basis the switchboard in an exchange of 2,000 subscribers, would contain ten sections, that of a 5,000 exchange 25 sections, and that of a 10,000 exchange 50 sections, consequently each section in exchanges of these capacities would contain respectively 2,200 jacks, 5,200 jacks, and 10,200 jacks. The total number of jacks in a 2,000 exchange is therefore 22,000. The average mind would at once arrive at the conclusion that the total number of jacks in a 5,000 switchboard would be two and one-half times that of a 2,000, or 55,000, and that the total number in a 10,000 switchboard five times that of the 2,000. A 5,000 capacity switchboard, however, would contain twenty-five sections of 5,200 jacks each, or a total of 130,000, while a 10,000 capacity switchboard with its fifty sections of 10,200 jacks each, would contain 510,000 jacks. For sake of argument, we will say that each jack with its connection and labor, represents a cost of $1. Each new subscriber added to a 2,000 exchange has to be 'multiplied' into ten sections, necessitating ten jacks; but each new subscriber added to a 5,000 exchange has to be 'multiplied' into

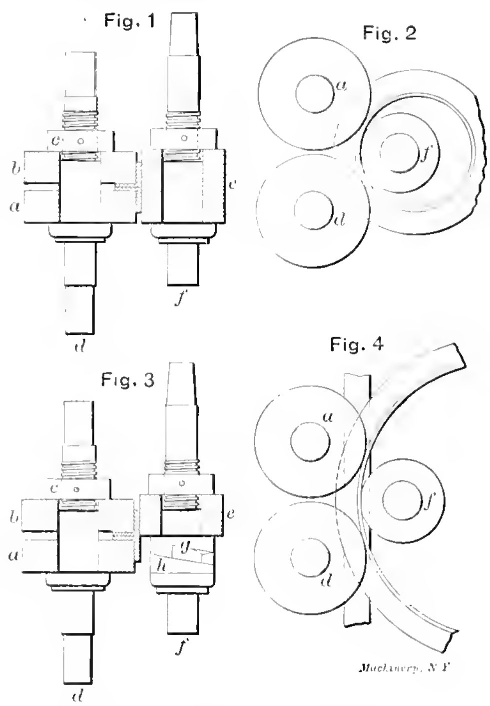
twenty-five sections, requiring twenty-five jacks; while each new subscriber added to a 10,000 exchange has to be multiplied into fifty sections, requiring fifty jacks. Now, as to the number of 'hello girls' necessary to operate exchanges of the size mentioned. While one operator can take care of each section of a 2,000 capacity switchboard, the larger exchanges require three or more operators per section, besides assistants, relief operators, and monitors. It is, therefore, evident that a company starting out with 2,000 subscribers, on a basis of say $50 per year for service, makes less profit on each 200 subscribers added; and such is the decrease in the profit as the exchange mounts up to 5,000 or 10,000 that the company must either increase its rates or quit.

"One of the most interesting exhibits in the St. Louis Exposition is that of the invention of a German named Faller, who has succeeded in eliminating the multiple feature, not only from automatic practice, but also from present manual practice. So great are the savings effected by this elimination of the 'bugaboo' of telephony that we may, in the near future, look for, not only much lower rates, but also what is almost as much to be desired—infinitely better service."

METHOD OF BENDING ANGLE BARS.

Energie, December 5, 1903, p. 3.

When an attempt is made to bend angles into a circular form it frequently happens that the ends do not close because the varying resistances of the different parts of the section throws these ends out of the same plane. In order to avoid this trouble Kottgen & Co., of Barmen, have designed the apparatus shown in Figs. 1, 2, 3 and 4. The principle of operation is to set the angles back to back so that the varying forces



Illustrating Method of Bending Angle Iron.

in each are working in opposite directions to each other and thus hold them in the same plane. Figs. 1 and 2 show the apparatus as arranged to bend two angles at the same time. If but one angle is to be bent the arrangement shown in Figs. 3 and 4 is used. The regulating screw g and h makes it possible to so adjust the roller e that it only acts upon one angle, which is so guided by the other that it is prevented from turning out of its own true plane. G. L. F.

THE ACTION OF PUMPS.

Practical Engineer, August 5, 1904.

From a hasty and superficial consideration no mechanical operation appears simpler than pumping fluids, whereas, under some considerations, it requires most carefully-designed machinery, and a thorough grasp of all the effects of moving fluids, before the operation can be successfully accomplished. Referring in the first place to the suction action of a pump, the plunger is followed by a plug of water in the whole length of the suction piping, and the effect of this water may be likened to so much dead weight added to the plunger, the inertia of which will be felt by the reciprocating parts and the crank pin. This action will show that an air chamber on the suction is a very necessary provision where the length of suction pipe is considerable. Turning now to the delivery action, we have, when the pump is about to commence its stroke, the whole mass of water in the pump chamber and the rising main inert, and this mass is suddenly set in motion by the advance of the plunger. It is clear, therefore, that severe shocks will occur where the delivery pipe is of great length. The above conditions exist where the valve action of the pump is perfect, but when faulty valves are present further shocks will be encountered. Consider, for instance, the effect of a sluggish closing of the delivery valves. When the plunger has attained its extreme stroke and begins to return, it will be followed by the whole volume of water in the rising main, but this motion will only continue so long as the delivery valve remains open. When this has closed the motion will be suddenly arrested, and great shocks will be felt unless air chambers are provided. In addition to the actions just described, there is the effect of a sluggish action on the part of the suction valves, as well as the effect of a restricted suction passage, but enough has already been said to indicate the nature of the shocks encountered by pumps. When these are considered, the frequent fractures and breakdowns which occur will not appear to be very mysterious; and this article will have served its purpose if it will lead some designers to realize that pumps have to withstand other stresses than those due to the mere statical head of the fluid.

THE ENGINEER AS A BUSINESS MAN

Extract from Address by A. C. Humphreys to the Students of University of Wisconsin.

About eighteen years ago I was called in to examine a process for which it was claimed that from two barrels of oil could be produced 200,000 feet of gas, high in candle-power and high in calorific-power. The promoters were able to produce, in verification of their claims, certificates from a number of gas engineers, and, I am sorry to say, from two professors of high reputation, members then of the faculty of a prominent engineering college. The certificate of one of these professors stated that the volume of gas produced under his observation confirmed the claim as to volume. The other professor's certificate stated that the gas produced had been found to be equal in candle-power and calorific-power to the claims. I noticed, however, that these certificates showed that the work on volume and the work on intensity or quality had been performed on different days. I was reluctant to undertake an investigation because manifestly the claims were ridiculous. On account of several people strong in the financial world, friends of our company, being concerned I was finally persuaded to undertake the investigation. I went off with a number of my men, set up the apparatus and left it in charge of a man who is now my partner and who at that time had only recently graduated from Stevens Institute. In giving him his instructions I told him that when he signed his report it would be necessary for him to bear in mind that when he affixed his signature I should understand that every word in his report he was personally responsible for; that he had taken nobody's word for anything, even to the minutest detail. He made the remark that this would be liable to put him into some very embarrassing positions. I told him it was sure to do so. Being a very polished Southern gentleman, this was evidently very disagreeable to him. The work went on for six weeks. We were constantly hampered by objections to the measures we were taking for the final determination. I visited the works myself once a week and it was apparent finally that oil was being introduced to the apparatus surreptitiously and I told my men to find the hidden pipe which was so being used. Shortly after my return from this last visit I received a telegram from my assistant in charge saying: "Have discovered the pipe. Can do nothing unless I seal the valve. This will indicate a lack of confidence. What shall I do?" I wired back: "You have your instructions and know what will be expected if you sign the

report." I received another telegram in reply: "Valve sealed." The next morning I got another telegram: "Works burned down, valve, seal, and all." So we had finally forced them to face a disclosure of the fraud and they preferred to have an accident at the works.

THE RESISTANCE OF EMERY WHEELS TO RUPTURE.

La Revue Technique, June 25, 1904, p. 660.

The Prussian government have fixed a maximum limit to the circumferential speed of emery wheels. For wheels made with a vegetable binder this limit is 82 feet per second, and for those with a mineral binder it is 49 feet per second. In the opinion of some German engineers, these figures seemed too low, and Prof. Grubler was commissioned to ascertain the bursting speed of wheels of different sorts.

The apparatus used consisted of an arbor 2 inches in diameter which is guided at the upper end by two collars held between two horizontal plates, set about 7⅞ inches apart. These latter were supported by two I-beams set about 11 inches apart. The wheel is centered and mounted at the lower end of the shaft. The whole rested upon a block 11⅞ inches thick, which in turn was supported on the sides of a trough nearly 4 feet deep and about 35½ inches wide. The arbor is driven by means of a grooved pulley over which a cord runs, and which can be driven by an electric motor at a speed of 1,600 revolutions per second. This latter can, however, be regulated at will, and a tachometer, driven by gearing, indicated upon a dial the speed at any instant. The wheels were fastened to the arbor by two metallic disks of 7⅞ inches diameter between which felt washers were screwed.

As the speed of the wheels was increased two critical values were brought out that were characterized by the more or less violent vibration of the shaft. They were caused by its elasticity and the torsion of the supports. They did not appear to bear any ratio to the speed of rupture or the explosion of the wheel, but are the more pronounced as the center of gravity of the wheel varies from the center of rotation.

From theoretical consideration alone it would appear that the maximum stress carried by the wheel is to be found at the circumference of the circular hole in contact with the shaft, and an examination of the broken wheels showed that the cracking had proceeded from the center to the circumference.

These wheels were all about 19⅝ inches in diameter, and the highest speed attained was 4,340 revolutions per minute, or 374 feet per second at the periphery.

As an expression of the safe speed the following formula has been deducted which gives the value of the maximum tension t of a wheel with an internal diameter i, an external diameter e, a specific weight w, and a circumferential speed u.

With metric measurements the formula is

$$t = \frac{3\,w}{4\,g}\,u^2\left[1 + \frac{1}{3}\left(\frac{i}{e}\right)^2\right]$$

which when referred to English measurements becomes

$$t = \frac{w\,u^2}{62\,g}\left[1 + \frac{1}{3}\left(\frac{i}{e}\right)^2\right]$$

g being the acceleration of gravity.

By adopting 10 as a coefficient of safety, the above formula gives the following as the safe peripheral velocities of various types of wheels:

	Feet per Second.
Wheels with a vegetable binder (rubber)	102
Wheels with a mineral binder (magnesia)	88½
Wheels with a porcelain binder	78

G. L. F.

RESISTANCE OF RAILWAY TRAINS.

Zeitschrift des Oesterreischischen Ingenieure Vereins, December, 1902.

The author, after having reviewed the trials of M. F. Barbier on the Northern Railway of France on the resistanee of trains, gives the results of other independent tests of the same kind to secure similar data regarding Austrian rolling stock. The result of these experiments has been presented in the same form as those of Mr. Barbier, and the formula derived is $R = a + bV + cV^2$, in which R is the resistance of the car in kilograms per ton of material, V the speed in kilometers per hour, and a, b and c constants which are then reduced to a graphic formula where the several factors are set forth.

These tests were not made by means of indicators and dynamometers, but by observing the speeds and accelerations which the vehicles attained upon different grades, a speed that amounted to from 36 to 18 miles an hour, and sometimes held this for a comparatively long time. In the matter of cars at least 323 trains were used whose weight, length and composition were varied to correspond with the condition of actual service.

The author also notes the difference between this method of testing and the dynamometer method, of which he has made no use. He also gives the principal dimensions of the vehicles used and the curves obtained, not only by himself but by Leitzmann, Wittenberg, Clark and others in former researches. Among other formulæ given are $R = 3.8 + 0.025V + 0.001V^2$ (between 24 and 48 miles an hour) for a 4-4-0 compound locomotive weighing 55.6 tons and having a six-wheeled tender weighing 36.7 tons in working order, attached; and $R = 1.6 + 0.184V + 0.00046V^2$ for four-wheeled cars weighing from 11 to 15 tons.

In conclusion, M. Sauzin summarizes the numerous influences which tend to modify the resistances of trains, such as wind, exposed areas, lubrication, temperature, etc.

G. L. F.

MAKING CASTINGS IN ALUMINUM.

Practical Engineer, July 15, 1904, p. 75.

The method adopted in preparing molds and cores for aluminum work is necessarily somewhat the same as for brass, but there are particular points which need attention to insure successful work. Both in the sand and the making of the molds there are some small differences which make considerable variation in the results, and the temperature at which the metal is poured is a consideration of some importance.

In selecting the sand, which should not have been previously used, that of a fine grain should be chosen, but it should not have any excess of aluminous matter, or it will not permit of the free escape of gases and air, this being an important matter. Besides this, the sand must be used as dry as possible consistent with its holding against the flow of the metal, and having only moderate compression in ramming.

In making the molds it is necessary to remember that aluminum has a large contraction in cooling, and also that at certain temperatures it is very weak and tears readily, while all metals shrink away from the mold when this is wholly outside the casting, but they shrink on to cores or portions of the mold partly inclosed by metal. Thus, if casting a plate or bar of metal, it will shrink away from the mold in all directions; but if casting a square frame, it shrinks away from the outside only, while it shrinks on to the central part or core. With brass, or iron, or such metals, this is not of much importance, but with some others, including aluminum, it is of great importance, because if the core or inclosed sand will not give somewhat with the contraction of the metal, torn or fractured castings will be the result. Both for outside and inside molds, and with cores used with aluminum, the sand should be compressed as little as possible, and hard ramming must in every case be avoided, particularly where the metal surrounds the sand. The molds must be very freely vented, and not only at the joint of the mold, but by using the vent wire freely through the body of the mold itself; in fact, for brass the venting would be considered excessive. With aluminum it is, however, necessary to get the air off as rapidly as possible, because the metal soon gets sluggish in the mold, and unless it runs up quickly it runs faint at the edges. The ingates should be wide and of fair area, but need careful making to prevent them drawing where they enter the casting, the method of doing this being known to most molders.

If it is considered desirable to use a specially made up facing sand for the molds where the metal is of some thickness, the use of a little pea or bean meal will be all that is necessary. To use this, first dry as much sand as may be required and pass through a 20 mesh sieve, and to each bushel of the fine sand rub in about 4 quarts of meal, afterward again passing through the sieve to insure regular mixing. This sand should then be damped as required, being careful that all parts are equally moist, rubbing on a board being a good way to get it tough, and in good condition, with the minimum of moisture.

The molds should not be sleeked with tools, but they may be dusted over with plumbago or steatite, smoothing with a camel's hair brush, in cases where a very smooth face is required on the castings. Preferably, however, the use of the brush even should be avoided. Patterns for aluminum should be kept smooth and well varnished, as the better the face of the pattern the smoother the mold is left, as a rule, a point worthy of consideration in relation to the making of molds for casting all kinds of metals and alloys.

In melting the metal it is necessary to use a plumbago crucible which is clean, and which has not been used for other metals. Clay or silica crucibles are not good for this metal, especially silica, on account of the metal absorbing silicon and becoming hard under some conditions of melting. A steady fire is necessary, and the fuel should reach only about half way up the crucible, as it is not desirable to overheat the crucible or metal. The metal absorbs heat for some time and then fuses with some rapidity; hence the desirability of a steady heat, and as the metal should be poured when of a claret color under the film of oxide which forms on its surface, too rapid a heating is not advisable. The molding should always be well in advance of the pouring, because the metal should be used as soon as it is ready; for not only is waste caused, but the metal loses condition if kept in a molten state for long periods. The metal should be poured rapidly, but steadily, and when cast up there should not be a large head of metal left on top of the runner. In fact, it is rather a disadvantage to leave a large head, as this tends to draw rather than to feed the casting.

With properly prepared molds, and careful melting, fluxes are not required, but ground cryolite—a fluoride of sodium and aluminum—is sometimes used to increase the fluidity of the metal. In using this, a few ounces according to the bulk of metal to be treated is put into the molten metal before it is taken from the furnace, and well stirred in, and as soon as the reaction apparently ceases the pot is lifted and the metal at once skimmed and poured. The use of sodium in any form with aluminum is very undesirable, however, and should be avoided, and the same remark applies to tin, but there is no objection to alloying with zinc, when the metal thus produced is sold as an alloy.

Aluminum also casts very well in molds of plaster of paris and crushed bath brick when such molds are perfectly dry and well vented, smoothness being secured by brushing over with dry steatite or plumbago. When casting in metal molds, these should be well brushed out with steatite or plumbago, and made fairly hot before pouring, as in cold molds the metal curdles and becomes sluggish, with the result that the castings run up faint.

SUPERHEATED STEAM FOR LOCOMOTIVES IN GERMANY.

Abstract of Consular Report No. 2,016 by Dean B. Mason, Berlin, Germany.

Since the year 1898 the Prussian State railroads have been carrying on experiments with locomotives using superheated steam, and these experiments have done much to elucidate and overcome the technical difficulties incident to the use of superheated steam by locomotives. While during the last ten years the utilization of superheated steam with stationary engines has become general in Germany, it has been employed only on a small scale, during the past few years, with locomotives. Owing to the great amount of power which a locomotive of limited size must produce, it is far less economical of steam than the stationary engine, whose bulk is subject to no limitation, and its steam is far more heavily charged with moisture, so that theoretically, at least, the advantages obtained by the use of superheated steam in locomotives should be greater than in stationary engines.

The first two engines equipped with Schmidt superheaters, put into service in 1898 by the Prussian State railroads, are still running, and after various modifications had been made they gave, according to an official report, entire satisfaction, and are to-day considered two of the best simple engines for express and ordinary passenger service, in spite of the fact that they are in various respects not up-to-date in construction. The next order was for four simple locomotives in which the superheater was placed in the smokebox instead of in the boiler, and all of these engines have proved satisfactory, according to the report of Baurath Garbe, in respect to power, economy in the use of water and coal, and the ease with which they start. At present there are some 50 locomotives equipped with the Schmidt superheater in use or in course of construction for the Prussian State railroads, and all the different types of locomotives at present in use on this system are being tried with the Schmidt superheater. No official reports of the results obtained have been published more recently than 1902. In an article published by C. W. Kriedel, of Wiesbaden, the results shown by the tests made public up to that time were summed up as follows:

Locomotives using superheated steam under favorable conditions use 5 per cent. less coal and 15 to 20 per cent. less water than engines using saturated steam; owing to its lightness, superheated steam is especially effective when the action of the piston is very rapid; and greater power for a short time can be maintained by engines using superheated steam than by those using saturated steam.

Brückmann, one of the most indefatigable and exhaustive investigators, calculates that under normal conditions there is a saving of 20 per cent. in an ordinary simple steam engine that employs superheated steam over one that does not, while the saving in coal is only one-half per cent. when the work of a simple engine with superheater is compared with that of a compound engine without it. Owing to the difficulty of obtaining absolute accuracy, the results of the various tests of the efficiency of locomotives using superheated steam as compared with other engines have varied considerably, and there exists more or less difference of opinion as to the limit of economy in fuel and water that has been and is likely to be attained by the use of superheated steam.

Geheimrath Garbe maintains that in considering the question of expense the simple engine with superheater should be compared with the compound locomotive. He maintains that the use of the compound engine has been rendered desirable only by the defects of ordinary steam, that with highly superheated steam the simpler and less expensive twin engine, working with steam at much lower pressure, is capable of taking its place for all purposes, and that it will be possible by the use of superheated steam to reduce the types of engines used in Germany to five or six. He asserts that while the compound engine is more economical, is capable of attaining greater speed, and is more powerful at high speed than the simple engine when ordinary steam is used by both engines, the advantages of the compound engine disappear when it is compared with a properly constructed simple engine using superheated steam at from 570 to 620 degrees F. He bases his judgment on experience obtained on the Prussian railroad and on the inherent superiority of highly superheated steam.

The most recent trial that an engine equipped with the Schmidt superheater has undergone was at the high-speed steam locomotive tests made on the track between Marienfelde and Zossen, when an engine built by the firm of Borsig and equipped with a Schmidt superheater made a speed of 79½ miles with a full train of six cars, and a speed of 84½ miles an hour with a train of three cars, the energy developed being about 2,000 horse power. The Borsig engine, unlike the three other engines, was not built specially for these trials, but only one of its competitors equaled it in speed.

It is likely that the Schmidt superheater would have been adopted already on a much larger scale were it not for the opposition which it has encountered from the partisans of

other superheaters. Encouraged by the success obtained by Schmidt, other inventors have taken up the same line of work and have produced superheaters of varying degrees of practicability. Of these the Pielock is the one that has received the most attention in this country, and would appear to be the most serious competitor to the Schmidt invention. It consists of a chamber or metal box located in the boiler, from which it is separated by a metal wall through which the boiler flues pass. The interior of the superheater is divided up by walls in such a manner that the steam in passing through the different subcompartments is made to circulate along the boiler flues. Owing to the risk of injury to the flues, it has not been found desirable to place the superheater too close to the furnace. The temperature in the furnace flues is reduced by passing through the water of the boiler, and the temperature attained by the steam in the superheater is from 450 to 500 degrees F.

As will be seen by the foregoing, there exists a radical difference between the Schmidt and Pielock superheaters. While in the former the steam is heated to from 570 to 620 degrees F. by means of one large flue, which conveys part of the furnace gas to the superheater chamber, in the Pielock system all the furnace gas is passed through the superheater by means of the boiler flues, the steam being heated only from 450 to 500 degrees F.

In all, some ten engines have been or are to be equipped with the Pielock superheater by the Prussian State railroads, but it has not been possible to obtain satisfactory information as to the results recently obtained. Only old engines have been experimented with, one of the principal advantages of the Pielock over the Schmidt superheater being that old engines can be equipped with it without expensive alterations. In order to equip an engine with a Schmidt superheater capable of giving the steam a high temperature it is necessary to enlarge the smokebox in order to make room for the superheater, and in case the superheater is made smaller, the old smokebox being retained, it is possible to obtain only moderate temperatures, similar to those obtained by the Pielock system.

It is claimed for the Pielock superheater by its inventor that it can be used on old as well as new locomotives, as it can be adjusted to any boiler, and that no loss of power is entailed, as owing to the greater efficiency of the superheated steam, the space taken up in the boiler is more than compensated for; that owing to the simplicity of construction of the Pielock superheater it is cheaper than any other type, costing from $450 to $600 only for a two or four-cylinder Prussian express locomotive; that with it there is no loss from radiation, as any heat lost in the superheater raises the temperature of the water in the boiler; that it is less subject to repair than any other superheater, and needs no special cleaning other than the cleaning of the boiler flues, which would have to take place anyway; and that no extra labor is entailed on the part of the locomotive engineer.

It is claimed by the adherents of the Schmidt system that it is impossible to obtain sufficient increase in efficiency with the moderate temperature attained by the Pielock superheater to justify its use; that frequent repairs to the furnace flues passing through the superheater will be inevitable; that they cannot be examined without being taken out; that this involves serious damage to the superheater and to the walls to which they are made fast; and that a flue thus removed cannot be used again. The partisans of the Pielock system claim, on the other hand, that the large furnace flue used in the Schmidt system is likely to leak where it is connected with the superheater; that the highly superheated steam is very injurious to the machine parts which it comes in contact with; and that too much heat goes out of the smokestack.

WATER HAMMER IN STEAM PIPES.

The Locomotive, July, 1904.

Attention should be called to the danger of putting in steam pipes in such a way that they can act as traps, and collect any considerable quantity of water of condensation. When steam is turned into a pipe containing entrapped water, it is unfortunately common experience that the entering steam causes the water to surge about in some way that is not entirely understood, so that it is often thrown against the fittings with such violence as to cause some part of the pipe line, or its connections, to break. The reality of the danger from entrapped water in piping is often disputed by those who have not seen its results; but the extensive experience of the Hartford Steam Boiler Inspection and Insurance Company indicates that accidents from this cause not only happen, but happen often. In the following they give several cases of the kind that have recently come under their notice.

Figs. 1, 2 and 3 represent certain steam connections which gave trouble, not long ago, in an electric lighting plant. The boilers were of the water-tube type, with three drums each; the drums of one of these boilers being shown. Immediately

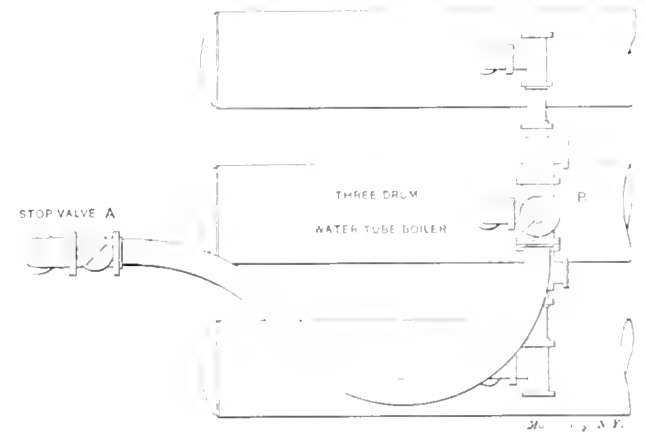


Fig. 1.

upon the top of this boiler there was a safety stop valve, *B*, which was designed to close automatically in case of any abnormally violent rush of steam through the feeder to which it was attached. This automatic valve was closed at the time of the accident, and another stop valve, *A*, situated on the same feeder where it entered the main, had also been closed. The boiler had been out of service for a time, but pressure had been raised upon it again, and it was about to be "cut in" with the other boilers in the battery. For this purpose the stop valve *A* was opened, the intention being to open the automatic valve, *B*, immediately afterward. It is probable that, owing to leakage through one or the other of the two valves, there had been an accumulation of water in the space between these valves; the entering steam causing this water to surge around through the curved pipe in such a way as to throw it violently against the automatic valve. At all events, the stop valve, *A*, was hardly opened when a section of the casing of the automatic valve was knocked out, as indicated by the shaded area in Fig. 3; several men who were standing near by being also scalded. Where two valves are used on a steam pipe in this manner, provision should always be made

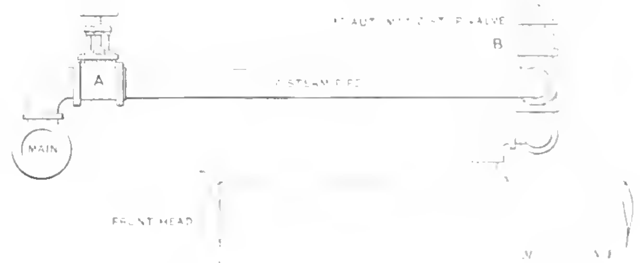


Fig. 2

for draining the space between them before either valve is opened; and when one of the valves is opened, it should be opened very slowly indeed. Furthermore, before any considerable quantity of steam is admitted to the pipe, both valves should be eased off from their seats slightly, to establish a moderate circulation, this being allowed to continue for some moments before the valves are opened further.

Fig. 4 illustrates another case, quite similar in its general aspects to the one described above. The boiler was here of the vertical water-tube type, and there was a gate valve in the branch pipe near the boiler, as well as a globe angle valve where the branch pipe entered the large main. From the circumstances attending the accident here under consideration,

and from the close similarity between it and other accidents in which water-hammer was undoubtedly the chief and perhaps the sole factor in determining the destruction, we are confident that this was also a case of water-hammer action. There had undoubtedly been leakage through one or both of the valves shown, so that the steam pipe had become more or less filled with water. At any rate, when the valve *B* was opened, the casing of the valve *Y* was almost immediately fractured, being broken into several pieces. It will be understood that in an accident of this kind it is often very difficult indeed to prove, beyond further argument, just what the cause was. In the present case, it has been pointed out that the valve *B*, being a gate valve, would naturally not be opened very rapidly; and it has

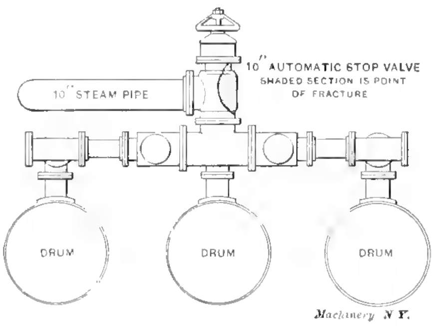


Fig. 3.

been argued that this lessens the probability that the accident was due to water-hammer action. However, the fact remains that the casing of the broken valve appears to have been abundantly strong to withstand any strain that could legitimately come upon it in its natural service, and, moreover, an examination of the fractured areas of the casing showed that they were sound, and without defects. It is also certain that the pipe would have trapped water if either of the valves had leaked, and that the accident occurred immediately upon steam being admitted through the valve *B*. Taking these various circumstances into account, assurance is felt that the cause was either water-hammer, or the sudden lifting of water from the boiler itself, as the steam was carried over into the comparatively cold pipe. Of these two explanations, that which assumes the presence of entrapped water appears to us to be the more probable, because, unless the gate valve, *B*, were opened with very unusual quickness, it is not probable that any great amount of water would be actually lifted from the boiler and thrown with violence down to the valve *Y*.

Drips are excellent things on a pipe line, if they are faithfully used; but there is a temptation to neglect them, after the attendant has operated the plant for a considerable time without trouble, and it is always better to design the pipe line so that no drips will be necessary, the pipe emptying itself by the natural action of gravity. The same precaution may be

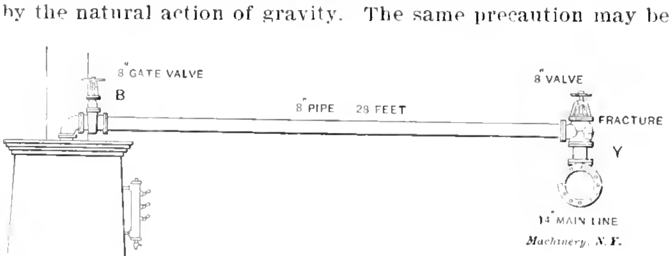


Fig. 4.

repeated here which was mentioned above—namely, in throwing a boiler into service which is connected with the main steam line by a pipe containing a double valve, the valves should be opened very slowly, each being eased from its seat and allowed to stand for a time, until the pipe becomes thoroughly heated, and any entrapped water that it may contain has had an opportunity to pass away.

In Fig. 5 is illustrated another accident, in which water-hammer was more evidently the cause of the trouble. In this case, the feeder pipe from the boiler to the main was bent, in order to clear a fore-and-aft line of pipe. There was only one valve in this instance, between the main pipe and the boiler; but it is easy to see that with the boiler out of service, and steam in the main pipe, there must be condensation in the bent feeder, and the water of condensation must collect, in large measure, in the lowest part of the feeder, near the stop valve. Some changes had been made in the steam plant where this accident occurred, and the valve was being opened for the first time. Two men were engaged in opening the valve, from which it may be inferred that it was not found to work entirely satisfactorily. Moreover, there was a difference in pressure of 30 pounds between the boiler and the steam main, the pressure in the main being 150 pounds, and that in the boiler 120 pounds. A boiler should never, under any circumstances whatever, be "cut in" with other boilers until the pressure within it is practically identical with that in the steam main; because, if this condition is violated, there is grave danger of the rupture of some part of the structure, owing to the suddenness with which the stresses are changed when the valve is opened. In the present case, water had collected in the lower part of the bent feeder, and when the valve was opened this water was thrown against the valve with such violence that the casing of the valve was fractured, the arch cap of the valve being broken away from the body of the chamber, and the valve disk, stem and part of the arch being blown up through the roof of the building. The casing of the valve was 5/8 inch thick, and subsequent examination showed that it contained a small blow-hole, though this defect was too trifling to affect the strength of the casing to any serious extent. Two men were seriously injured by this accident, one of them losing his eyesight entirely, while the other one lost one eye. The dotted lines in Fig. 5 show the ideal way in which this steam feeder should have been run, in order to avoid entrapped water. If it was necessary to bend the feeder, however, in order to avoid the fore-and-aft line of pipe referred to above, the feeder should have been bent in such a way that its highest part should come next to the boiler,

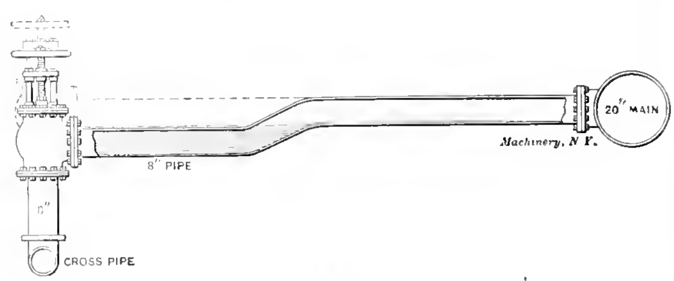


Fig. 5

instead of next to the steam main; the riser being correspondingly lengthened. There would then be no pocket in which water could collect, and the feeder would have drained itself into the steam main.

A steam line should never be arranged so that it can possibly entrap water. If there is any doubt about the perfect drainage in any particular case, drip pipes should be provided so that the doubtful part can be thoroughly drained before steam is turned into it; but it should always be remembered that any pipe whose safe condition depends upon opening of a drip, as a distinct operation to be performed before the valve is opened, must be regarded as an element of weakness about the plant. Steam valves, under all circumstances, should be opened and closed very slowly, and when a pipe contains more than one valve they should all be eased from their seats slightly for some moments, so as to permit of the establishment of a certain amount of circulation, before they are opened up fully. By attending to these various precautions, it should be quite possible to avoid, in large measure, the serious accidents that are continually occurring in connection with pipe lines, and which are attributable to water hammer action, or to other analogous causes.

CONDENSATION FALLACIES AND FACTS.

Mr. W. H. Booth, in Electrical Review, June 17, 1904, p. 983.

The excellence of a vacuum appears to be considered too much as a matter of the quantity of water sent through the condenser, if this is of the surface variety. This is because

the arrangement of a surface condenser is usually of an entirely promiscuous nature. A surface condenser has a large number of tubes, all equally supplied with water, and steam flows across these tubes equally in contact with their colder and warmer extremities. It would appear more rational to enclose the middle length of the tubes in a jacket fitting closely round the bundle of tubes, and compel the steam to effect an entrance to the bundle and travel longitudinally along the spaces between the tubes, emerging at the other end by a very much narrower uncovered band to the air pump. The water should flow along the tubes in a direction counter to the flow of the steam outside them.

The amount of water necessary for condensing a pound of steam can be calculated very simply and directly. Assuming that the water has a temperature of 50 degrees F., and that it is desired to leave at 105 degrees F., there is a gain of 55 degrees F., or a trifle above 55 thermal units per pound.

The steam contains about 1178 thermal units per pound, and if it leaves as water at 55 degrees F., it loses 1,123 units. Then 1,123 ÷ 55 is nearly 21. Therefore, with a properly designed condenser, the conditions named demand only twenty-one times the feed for condensation. If the passage to the air pump along which the air flows could be made to traverse tubes filled with the water flowing to the condenser, the bulk of the air might be reduced, and the vacuum improved somewhat. This supposes the dry air pump, or a separation between the water discharge and the air discharge. The excellence of a vacuum ought to be determined by the temperature of the effluent water, and this, in a counter-current condenser, should be a little warmer than the entering circulation water.

Ordinarily the condensed steam is as hot as, or hotter than, the circulation discharge. Thus, instead of 55 degrees F., it would have a temperature of 105 degrees F. The relative vacua at these two temperatures are 29½ and 27½, a difference of 2 inches, or 0.86 pound pressure. The temperature of the water marks the limit of the vacuum that can be obtained, but it is very doubtful, under even the best practicable conditions, if so good a vacuum as 29½ can be got. The air in the condenser, like any other gas, has a volume proportionate to the absolute pressure reciprocal. At 27½ inches vacuum, the absolute pressure is 1.189 pounds per square inch. At 29½ inches it is only 0.207 pound. The volume is thus nearly sixfold, and to maintain such a vacuum, the volume generated by the air pump would need to be multiplied by six.

This is, of course, the reason why the Parsons turbine condenser is fitted with a steam jet, the object of which is to gather air at extreme tenuity, and force it toward the air pump at a somewhat greater density, in order that the air pump may bite off a greater weight per stroke than it can when only drawing on an air space at 29½ inches vacuum. Let us see what is the relation between air and air pump. Each cubic inch of free air, or atmospheric air, which gets into the boiler or the engine, or the exhaust pipe, expands to seventy times its volume at 29½ inches vacuum. Reduced to air-pump dimensions, this means that an air pump, 13½ inches diameter, with a stroke of 1 foot, would only deal with about 25 cubic inches of air, or about two-thirds of a pint measure, whereas the same pump on a 27½-inch vacuum would deal with one-half gallon. It is to reduce this one-half gallon into two-thirds of a pint that a steam jet is employed. Its effective pressure to do this must be such as to overcome a resistance of one pound per square inch. It is not to be overlooked that this steam jet must be at once killed, or it would spread back into the vacuous space and vitiate the intensity of the vacuum. An air-pump bucket can only extract at each stroke its own generated volume of air, and this must be greater than the volume to which all the inleaking air expands. If this be not the case, the vacuum will fall off until the air density is so much greater that the pump can get hold of as much weight per stroke as leaks in during a stroke period. A very small difference of vacuum makes a very great difference in the capacity of the air pump to deal with it. The repeated use of the same feed water should cause very little air to find its way into boilers, and air, in a condenser, is in such cases almost wholly a matter of leakage at glands. Better vacua years ago were obtained than are usual to-day. One reason was the use of fibrous packings on low-pressure glands, and there is nothing to-day to prevent the same being employed on low pressure or vacuum glands, for these are no hotter than they were when steam of 30 pounds pressure was let into the cylinder. Another cause of air leakage is the long exhaust pipe to the condenser, carelessly jointed, and there are leakages through the valves which shut off the exhaust branches of each engine, not to mention other sources of air. These faults are what render the independent condensing plant so unsatisfactory in practice, because, instead of hunting up air leakages, the air pump is over-driven to conceal them.

The steam intensifier of the Parsons condenser is really a form of compound compressor, the steam jet representing the first cylinder of the compressor, and the ordinary pump representing the second cylinder. The whole combination is, of course, simply an air compressor, compressing to one atmosphere. The steam jet takes the place of the extra large first cylinders which it is necessary to use on the Rand, where the air at 6,000 feet elevation is of too low a density to provide weight sufficient in the ordinary sizes of machine used nearer sea level.

In a condenser the water demands a low temperature, or it will produce vapor to choke the air pump, and the air demands a large air pump to deal with it at high vacua. Hence the need for counter-current condensers for one purpose, and supplementary air condensers to cope with highly-expanded air.

INTERNAL COMBUSTION ENGINES AND THE DIESEL PRINCIPLE.

Mr. W. H. Booth, in Electrical Review, June 10, 1904, p. 975.

It has been pretty conclusively shown that economy in the gas engine attends on high compression, but practice has shown equally conclusively that high compression of an explosive mixture has a low safe limit. The compression of a gas requires the expenditure of energy, and this energy in the case of a perfect gas is converted entirely into heat energy, and manifests itself by rise of temperature. In a slowly running engine much of this heat could and would pass into the water jacket, and so far would be lost for useful work in the engine. Compressed quickly as it must be in any engine of moderate size per unit of effort, the gaseous mixture becomes heated to a high temperature, and becomes spontaneously explosive. Myself, I have little doubt that spontaneous ignition takes place more readily in the more highly hydrogenous mixtures, and this very real danger shuts out from high compression use the richer gases; and those with much hydrogen in their composition, such as the water gases and the coal gases, are unsuitable to be employed in high-compression engines. Mr. Thwaite, in his blast-furnace gas practice, has found that the very poor gas produced from a blast furnace, and containing very little hydrogen, is a very manageable gas. This may partly be due to its considerable constituent of carbon dioxide, which assists to delay ignition. Suffice it to say, that blast-furnace gas will safely endure an intensity of compression above what can be secured with richer and hydrogenous gas.

Now, in the Diesel engine, compression is entirely independent of the quality of the fuel, for the very simple reason that no fuel is introduced until it is wanted to ignite. Pure air alone is compressed, and therefore the intensity of compression is limited only by two factors—the ability of the mechanical construction to withstand the stresses, and the thermal possibilities involved. The high compression produces a temperature sufficient to cause ignition of the fuel, and this ignition takes place as soon as the fuel is introduced to the heated atmosphere in which it burns.

Thus the Diesel engine does act along very different lines from those casual lines of the ordinary internal combustion motor. Though the full cycle intended to be worked by Diesel has not been found practicable, a part of it has been secured, and combustion takes place on isothermal lines, the diagram of the Diesel engine being simply the compression

curve pushed forward by temperature, so that the air occupies a larger volume at the same pressure. Thermally, the advantage of this system is that the maximum pressnre may be employed that the machinery will permit, and there can be no pre-ignition. There is no sudden accession of pressure on the dead point, but the pressure may even rise a little after the crank has passed its position of zero effort. In this way there is less mechanical loss incurred through the imposition of a heavy pressure on the bearings during the time such pressure is producing no turning effort. Where early ignition takes place and produces this effect, much of the heat is passed directly to the water jacket, and therefore wasted. In gas and oil engine work it is of importance that the heat generated by combustion should pass very directly into mechanical work. Every engine is, of course, a compromise between full ignition on the dead point and the longest utilization of the pressure produced, and prolonged combustion, with a minimum of loss to the jacket. Early and complete ignition not only produces frictional loss, but jacket loss These losses are both saved by prolonged combustion, which, by purely academic men, is looked on as an error. Hence the importance of securing a satisfactory compromise. In the Diesel system this compromise, combined with the principle involved, enables an efficiency to be obtained as between indicated horse power and calorific capacity of the fuel of 42, if not 44 per cent., and well over 30 per cent. can safely be counted on, referred to brake horse power.

As a machine, the Diesel or other engine may be fully as frictionless as a steam engine, and recent tests of a Diesel engine have shown me that this is the case. I have also found that an indicated horse power hour can be got for about 0.32 pound of crude oil with a calorific capacity of about 19,000 B. T. U., and this points to a very efficient utilization of the heat value of the fuel. This high efficiency is a result due largely, of course, to the high compression which is possible only with the Diesel system of fuel admission. It is also partly due to the diminished friction and diminished jacket losses referred to, and these advantages may be more or less secured in other forms of engines than the Diesel.

The future improvement of internal combustion engines lies so much along the lines followed by Diesel that this motor may be studied to good advantage, for its system of compression removes the most serious limitations of the ordinary engine, and in weight of combustible per unit of energy output its record is far ahead of any other motor.

* * *

HOW CAR INSPECTORS ARE BEATEN.

A writer in the *Railroad Gazette*, who formerly was a car builder, throws a vivid light on some shady practices followed in car building shops when orders are taken on too close margin or the specifications are considered by the management to be somewhat too rigid. Perhaps equally as interesting tales could be told regarding the execution of certain supposed high-grade machinery if the perpetrators thereof were disposed to take the public into their confidence. The writer says:

"I remember when I was foreman of a shop in an Illinois town some years ago, before the advent of steel body and truck bolsters, we got a job that called for white oak bolsters. White oak was rather scarce and hard to get at any price, but it chanced that the shop was adjacent to a scrub oak country and that there were plenty of saw mills to supply the demand, so the superintendent decided to saw his white oak bolsters from scrub oak logs, securing thereby a much cheaper article and a much longer time on his bills. But the inspector whom the railroad sent out was wise on white oak, and the superintendent knew that the scrub oak has a peculiar smell which would distinguish it readily from the real article. The sample car was put up with white oak, as specified, and, in the meantime, the home product was cut and run to size as rapidly as possible, and was stacked up to dry in "the shade." Enough was run in this way to fill the entire contract. While this was going on, some fresh, recently cut white oak was procured and run through the planer. The chips were carefully collected and a decoction of white oak was brewed in a large iron kettle. Then we took a whitewash brush and gave the scrub oak bolsters a good smear of our special brewed white oak perfumery, and completed the job by painting the ends with mineral paint. The two together effectually killed the barn lot smell of the scrub oak. When the inspector came around he demurred at the dark appearance of the wood, but it was explained to him that it had lain out in the weather and was rain soaked. He passed our home-industry bolsters without a murmur.

"After the iron bolsters came into use it took a slightly different style of treatment to doctor them, but there were ways. Once the company by which I was employed had to turn out a thousand truck bolsters for another firm that was caught short on a contract. The understanding was that the other firm was to furnish the material and we were to do the work. The superintendent and I figured long and earnestly as a committee on ways and means, for our shop had never attempted anything like it before. There was an abundance of drilling and riveting to be done and no labor-saving appliances to do it. He finally decided that he would do it any way, and put on a night shift, as we got a pretty stiff price for the work. The bolster company sent an inspector down, who proved to be a terror, and we had to do most of the night shift work over again in the daytime, as they only got about one rivet out of ten tight. The inspector was always on the spot and every loose rivet had to be cut out and replaced by a tight one. Our night shift was recruited from around town and the surrounding country, and each of the boys was perfectly competent to follow along behind a mule, after the reins were around his waist so that the motive power would move man and plow together. They could haul logs, too, with a pair of steers at about one mile per hour, but when it became necessary to move up a peg and get a hot rivet down before the shrink was all out of it, the spurt lasted just one rivet, and that was all. Between the night shift, the superintendent, and the inspector, I had gotten to the stage where if any one so much as asked what time it was, I would tell him to cut it out and put in a new one, my mind being wholly on loose rivets.

"Finally, we got a new foreman for the night gang, and the new foreman sized up the situation and asked me to have a calker made. After that, we finished up the edges of our loose rivets with a good sharp calking tool, and when the inspector tested the plates, they sounded as tight and solid as if they were made out of one piece. The superintendent saw that it would not do to get perfect work all at once, so we left the inspector a few loose rivets now and then for the next week or so, but finally tightened them up to the satisfaction of all concerned. Out of that one thousand bolsters, I don't believe one hundred went out perfect, for there really did not seem to be any use in driving rivets tight when you could fix them up with the calker.

"When it comes to beating the inspector on castings, you have to get at it in a little different way, as castings have to turn out the way the patterns make them. A simple and effective way to get around this is to have a double set of patterns, with a private mark on each so that if you really want to you can tell which is which. This will save you maybe 10 or 12 dollars' worth of pig iron on each car, which would help keep the officers of the company in cigars and pay for an occasional watch or gold-headed cane if the inspector ever should happen to tumble on a short weight. When the inspector first arrives on the scene, with his mind full of responsibility and a disposition to test everything in sight, he finds a nice little stock of standard castings waiting for him. Maybe 25 cars of castings of all kinds are gotten out while he is familiarizing himself with the patterns and breaking a few wheels to test them for hammer blows and depth of chill. The scales are wheeled up to the piles, so that they can be weighed, the inspector pronounces his O. K., or suggests the desired changes, and then when he gets through we begin making green goods for him by exchanging patterns that make castings from eight ounces to ten pounds light, always keeping on hand a few of the right weight for emergencies."

SOME MICROMETER MEASURING INSTRUMENTS.

A. L MONRAD.

Having lately received letters from several persons inquiring about a combination micrometer I will endeavor to describe one of my own design, that I believe to be suitable for all classes of work. Fig. 1 shows an assembled view and the details of a 5-inch surface gage, which can be used as a height gage in obtaining the heights of projections from a surface, in locating bushings in jigs and work of various kinds. It is preferable to the vernier or slide caliper, now in use, because the different settings can be made more quickly and positively and for the readiness with which the graduations are discerned. It is also more convenient to handle in every respect.

The jaw projects beyond the base, is hardened and accurately ground for parallelism. One end is beveled and ground to an edge for use in scribing lines upon work. It has a 40 pitch, to a turning fit in the thimble *f*, and the adjusting nut *d* to compensate for wear.

On the same end a groove is milled 1-16 inch wide and 3-32 inch deep, that serves as a keyway for the pin *j*, which holds it in position and prevents it from turning. The barrel *b* is made of tool steel with a ¼ inch hole through the entire length. This must fit very nicely on the rod. It is graduated by a series of five annular grooves, 1 inch apart, that are of such form and depth that the clamping fingers at the end of part *h* when sprung in will fit accurately, thereby allowing the setting of the rod by inches to be quickly and positively made. There is also a 1-16 inch half round groove, planed its entire length on one side to fit the key *k*. The lower end is beveled so that the graduations on the rod are readily discerned. At the other end it is nicked down 3-32 inch, and ¼ inch wide to fit the bushing *e*, and this end is hardened and lapped to a true surface. Bushing *e* is made of tool steel, with a sharp

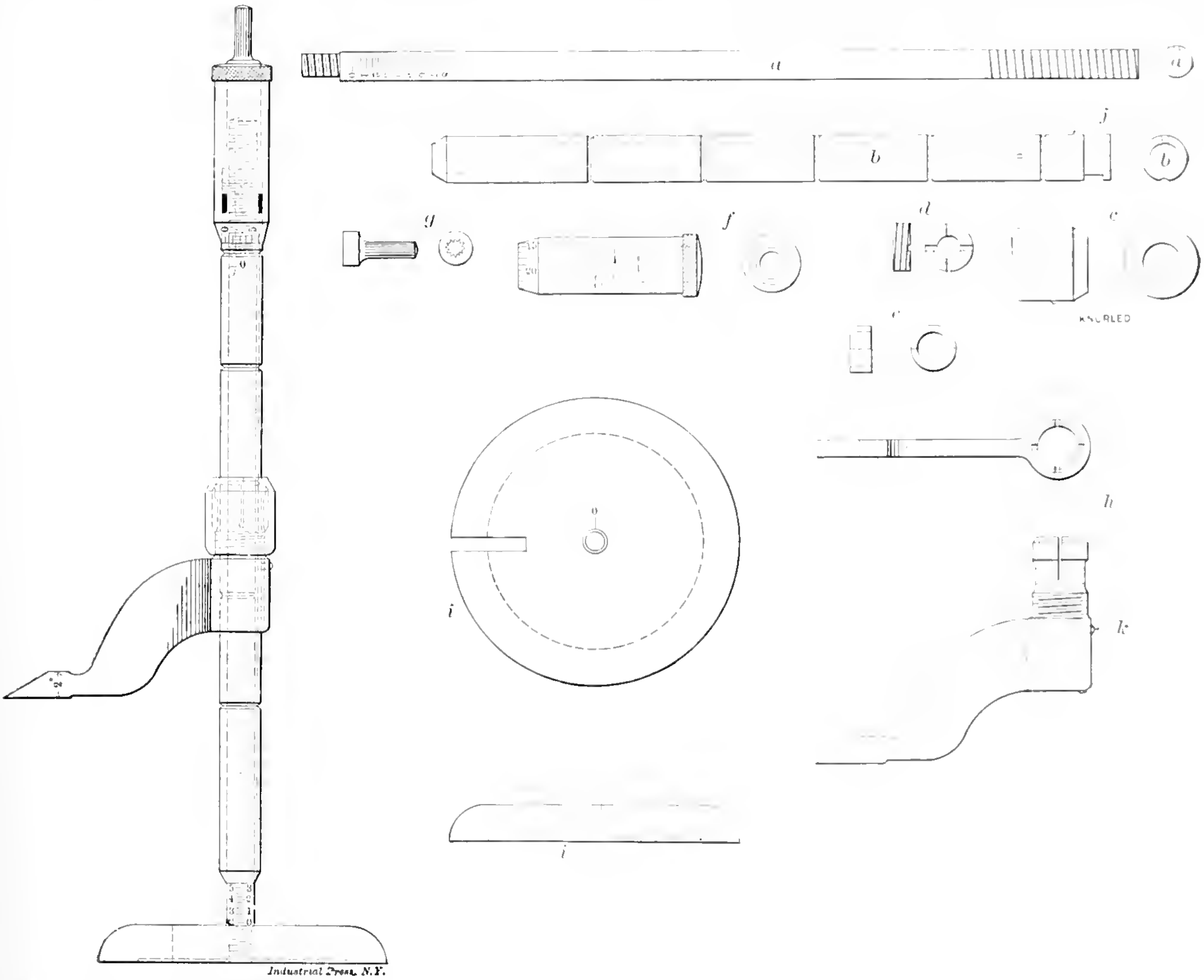


Fig. 1. Assembled View and Details of 5-inch Micrometer Surface Gage. The Spindle and Micrometer parts are used in other Combinations shown in the following Views.

range, by thousandths, from zero to 5 inches, and all fractions of an inch are obtained by means of the micrometer screw. Rod *a* is made of tool steel ¼ inch diameter and 7.5 inches long. At the lower end it is threaded 40 pitch to receive the base *i*. There are 40 divisions graduated on the lower end of the rod, each division being .025 inch wide. On the right are the figures for measurements from the surface to the point of the scriber, and on the left those for measurements from the faceplate to the top of the scriber, which may be used to set a tool to a certain distance, or to measure under a shoulder. (See assembled view.) The other end of the rod is threaded

A. L. MONRAD was born in Christiania, Norway, June 23, 1868. He received a high-school education and took a course in the Christiania College of Technology. His apprenticeship was served with the Winchester Repeating Arms Co., New Haven, Conn., and he has since worked for the Burgess Gun Co., Buffalo, N. Y., Colt's Repeating Fire Arms Co., Hartford, Conn., Lozier Mfg. Co., Toledo, O., and others. He served as foreman for two concerns. His specialties are gun work, designing and model work. Since coming to America in 1885 Mr. Monrad has acquired an experience equaled by few.

groove filed in a little on each side, and has a taper .010 to 1 inch, to fit the mouth of the thimble. After it has been hardened, ground, and lapped all over to a plug fit in the barrel, and with a driving fit on the thimble, break it apart so it can be placed in position when assembling. One end of the thimble is bored to fit the barrel, and at the bottom of this hole is threaded to receive the adjusting nut *d*. It is then placed on an arbor which has been turned in a chuck, and the center hole bored out, threaded to fit the rod, and chamfered out at the end to within 3-16 inch of the threaded part. The outside is shaped like an ordinary thimble with a graduation of 25 divisions. Speeder *g* has a tight fit in the thimble, and is turned down to ⅛ inch diameter, and milled its length by a 60 degree cutter. This gives a good grip and allows the thimble to be turned quickly.

The main body of the instrument, *h*, is made of tool steel. The lower end of the round portion is bored out in the center

so that the scriber will slide freely, but will have a good fit on the barrel. The upper end is formed into a split chuck, spring-tempered, which grips the barrel and holds it in position, while the lower part is threaded to receive the knurled cap *c*. This tightens the split chuck and serves to hold the part firmly in position on the barrel. In the lower end is fitted a round key *k* 1-16 inch diameter with the end bent at a right angle, whose purpose is to prevent the scriber from turning on the barrel. The point of the scriber is hardened and the upper and lower surfaces are parallel 0.2 inch apart. The cap *c* is made of mild steel, casehardened, knurled its entire made of 1-16 inch round Stubbs wire and bent at an angle of 90 degrees to fit the base.

Fig. 3 shows a 5-inch special, or disk micrometer which has proved very handy in measuring snap gages, slots, and thicknesses, and which may also be used as a height gage to ascertain the distance from a shoulder to the base. In measuring slots the outer sides of the disks are used and for thickness the inner sides. This form may also be used for setting tools on a planer or shaper. As shown in the cut, there are two sets of graduations on the rod, which enables the operator to see at a glance the measurement recorded either from the

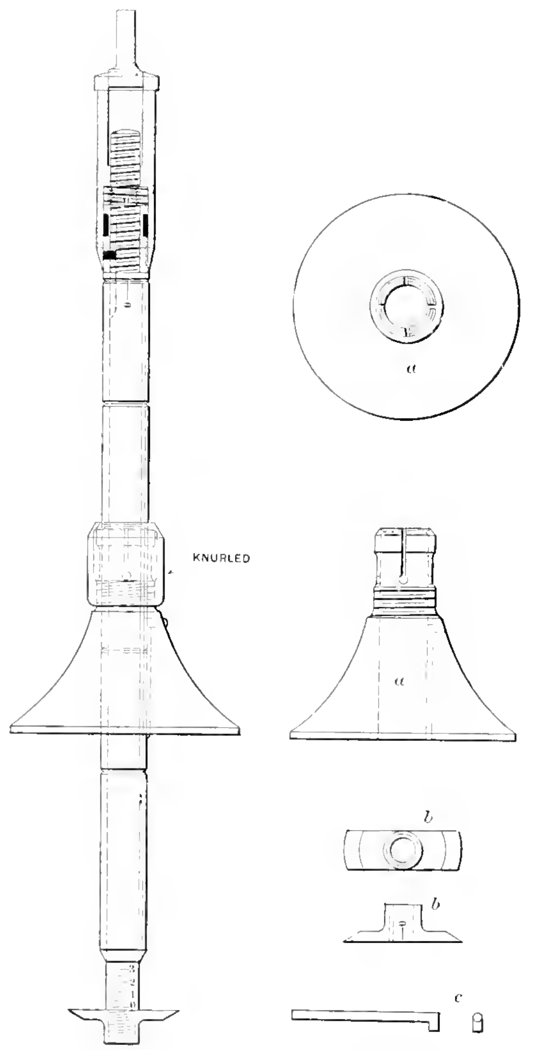


Fig. 2. Micrometer Tool used as a Scratch Gage.

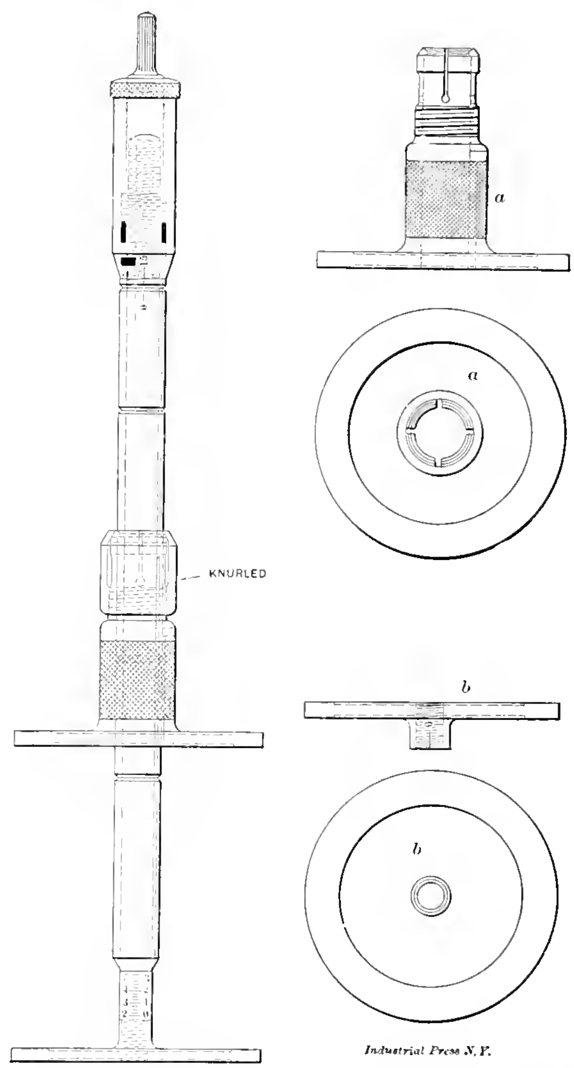


Fig. 3. Micrometer with Disk Attachments in place of the usual Jaws.

length on the outside, and fits the scriber chuck. The base block *i* is made of mild steel casehardened, and lapped at the surface. In the center it is tapped for 40 pitch thread to fit the rod, having a zero line to place it in the right position, and through the forward part of the block is a slot that allows the measuring or scribing jaw to come flush with the bottom of the base.

When ready to assemble the adjustment is very simple. Draw the zero line from the end 5/8 inch down on the barrel. When the tool is set to measure 1 inch correctly, draw the thimble over the split bushing, starting with the zero line at the end and continuing until in position.

Fig. 2 shows the same tool used as a scratch gage, which may be done by changing two pieces, and in this form will be found very convenient on a job that cannot be handled with a surface gage. This simple device has saved a lot of time, when accurate scratch line is wanted, where other means had to be applied. In addition it can be used as a depth gage, by exchanging the scriber *b* for the shoe *a*, shown in Fig. 8. The scriber *b* is made of tool steel, hardened and ground on each side to an angle of 60 degrees, and may always be set in the right position by drawing it to the zero line. The base *a* is made of tool steel and the top end forms a spring-tempered split chuck, using the cap *c*, shown in Fig. 1. The key *c* is inside or outside of the measuring disks. Each of the disks is 0.10 inch thick, so that the range of the micrometers is .400 inch for inside when .600 inch for the outside.

The disk *a* is made 2 inches in diameter and disk part is hardened, ground, and lapped. Great care must be exercised in lapping so as to make it perfectly true and parallel. The upper end is spring-tempered and fitted to the cap described for the first form. Disk *b* is hardened, ground and lapped, fitted to the rod in the usual manner, and screwed to the zero line.

By use of the parts shown in Fig. 4 we have a 5-inch micrometer caliper square which is preferable to the vernier caliper. It has the great advantage over the vernier, that the reading may be readily discerned without straining the eyes, and the use of a magnifying glass is avoided. Its manipulation is as easy as that of a regular micrometer.

The jaw *a* is fitted to the rod in the usual way to zero line, and the end is hardened and lapped to a finish surface. The jaw *b* is made in a similar manner, and knurled in the middle for a grip, the top end being fitted to the knurled cap. This forms a very neat and light tool; but it must be carefully and accurately made to be of value.

Fig. 8 shows a 5-inch micrometer lathe stop, which is one of the most accurate and universal tools in use. How difficult

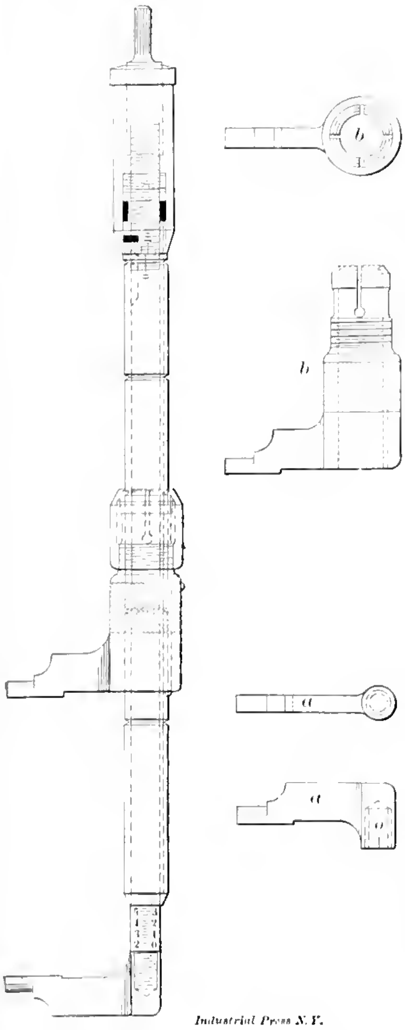


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Fig. 4 Five-inch Micrometer Square.

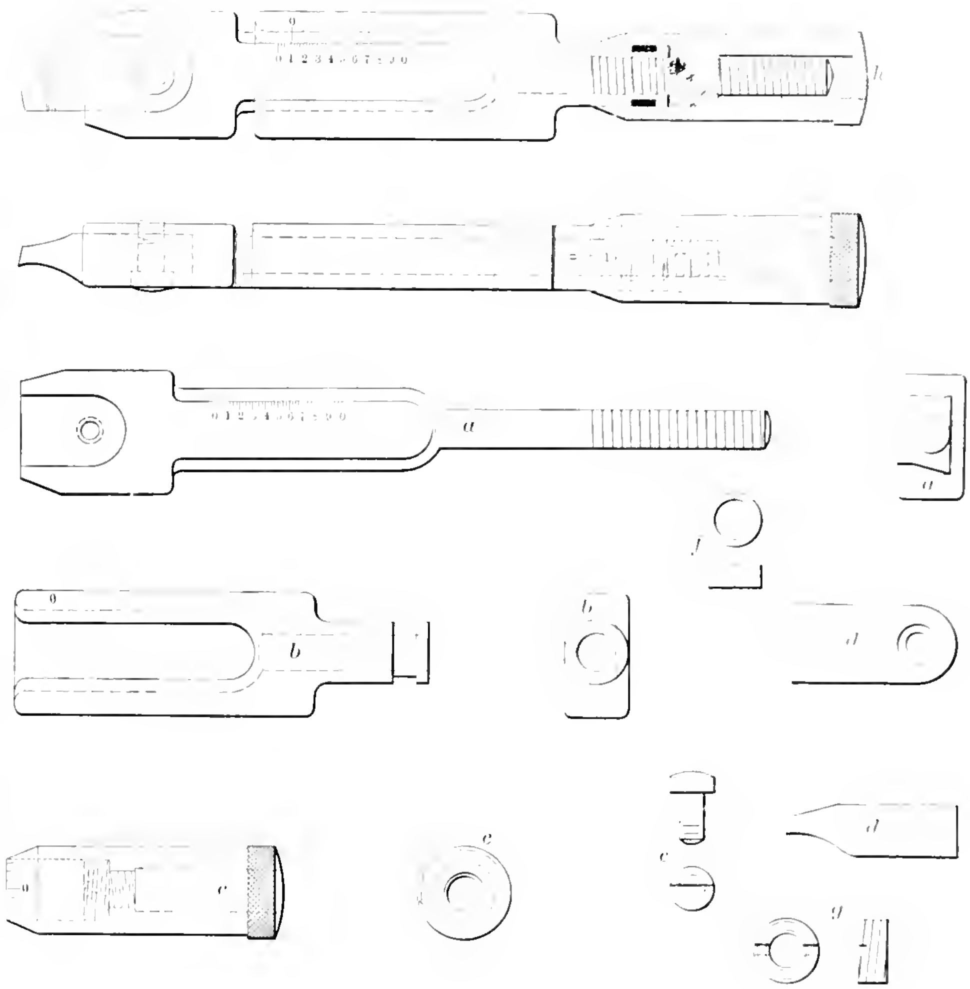

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Fig. 5. Micrometer Lathe Tool.

it often is to gage correctly a certain piece of work in the lathe or planer, especially when a distance of several inches is required, and frequently it becomes necessary to make a template or a length gage in order to get any halfway decent result. This tool "fills the bill" and does away with the "cut and try business." It can be used on either the right or left side and the holder is of so rigid a form that it does not show

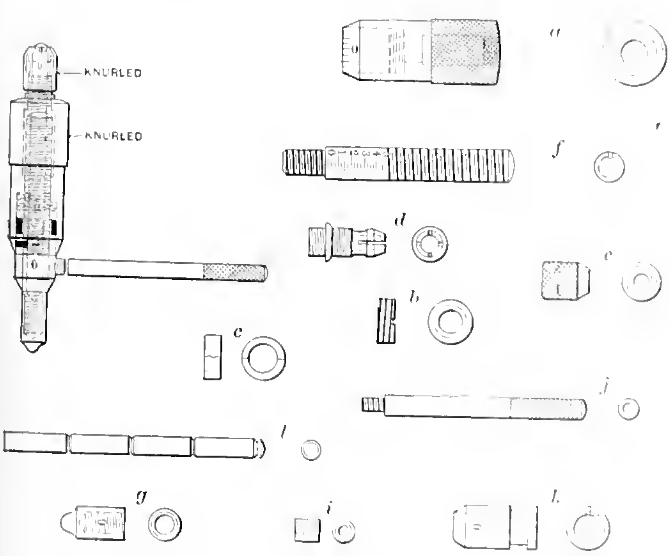

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Fig. 6. Small Inside Micrometer.

the tendency to spring, that is a serious fault with some. It is made to fit any machine of modern make, being clamped either on the rib or the flat surface.

The C-shaped clamp *b* is beveled a little on the inside, for convenience in adjusting in place on the machine and on the side is formed the usual spring chuck which fits the cap before described. On the end of the rod is fitted the shoe *a*, hardened and lapped, and drawn to the zero line by a spanner wrench fitting in the hole *c*. Thus we have five very handy tools almost combined in one, only slight changes being required. They save a lot of labor and do not take up so much room in the tool chest, where there is usually insufficient space.

Fig. 5 shows a micrometer finishing tool for lathe or planer. Most of the modern machines are supplied with a micrometer

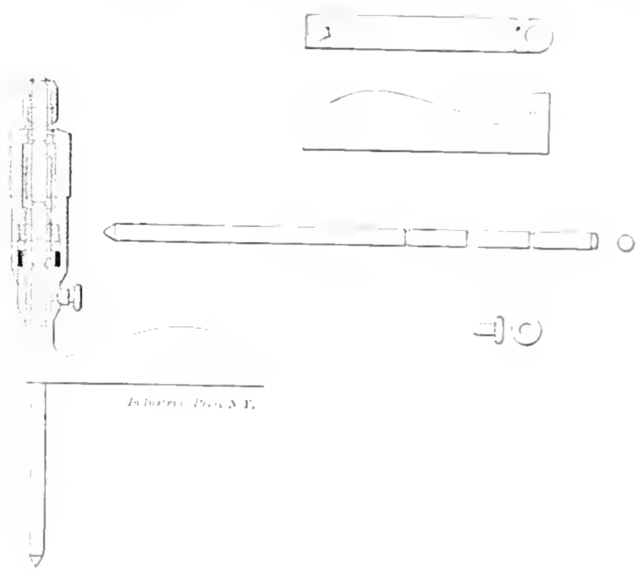

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Fig. 7. Micrometer Depth Gage.

screw stop, but the old ones are not, and on such this tool will come handy. It is designed on the same principle as the others, and the tool points are interchangeable. By making them fit snugly on the sides, the screw *c* will hold them firmly in position.

Part *a* is the main body of the tool. On the end a 40 pitch thread is cut to fit the thimble, and the sides are dovetailed to fit the holder *b*. Near the middle of one side one inch of

space is graduated, the lines being .025 inch apart. On the other end is a recess with a tapped hole to secure the tool d. The holder b a sliding fit in a, and on one end is the zero mark, while the other is nicked down to receive the split bushing f. The thimble is made in the usual manner as also the adjusting nut g.

Fig. 6 shows a neat little inside micrometer, designed for internal and lineal measurements. It is useful for measuring cylinders, and rings, etc., as well as for setting calipers, comparing gages and measuring parallel surfaces. The micrometer screw in the head has ½ inch movement, and the device is so designed as to be in touch with the other tools described above. The thimble a is constructed in the usual way, except that the top is fitted to receive the spring-chuck d. The adjusting nut b is made in the usual manner to compensate for wear, and the split bushing c as before described. On the thimble is screwed the tempered split chuck d, with the

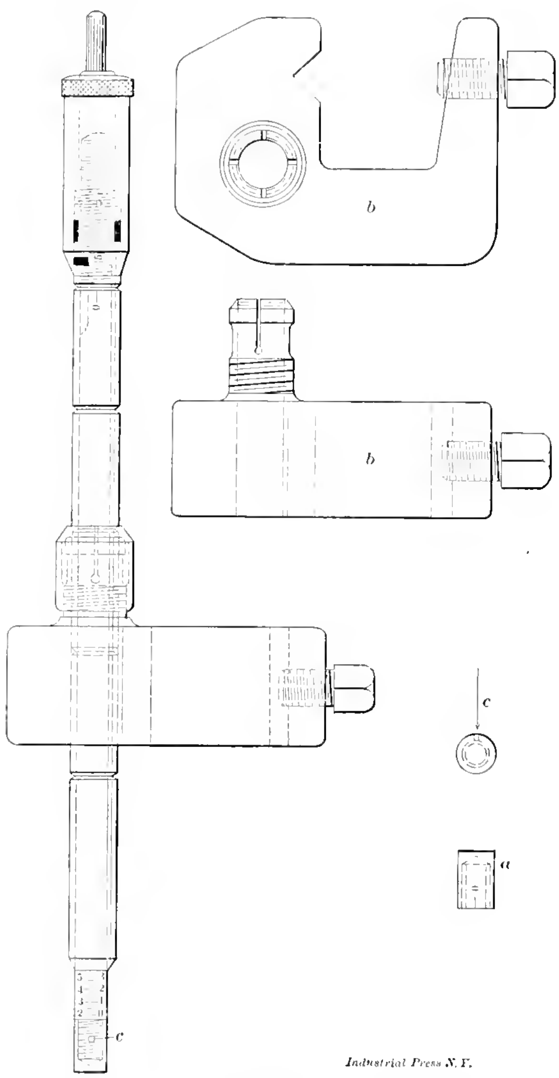


Fig. 8. Micrometer adapted for use as a Lathe Stop.

knurled cap e to clamp the rod in position. On the lower end of the screw f is fitted a shoe g which is shaped at the point like the rod. On the barrel k is soldered a bushing i which is tapped inside to receive the handle, thereby enabling one to take measurements in holes and other places where the micrometer could not otherwise be used. This handle may be exchanged for a thumbscrew, which may be used to lock the instrument after a measurement has been taken. Rods like that shown at l may be made of varying lengths.

Fig. 7 shows an instrument designed for measuring the depth of holes, grooves, or recessed parts, as well as gaging under a shoulder, or measuring the height of a small projection on a plane surface. The gage screw has a movement of ½ inch, and is encased and thus protected from dirt or injury. The measuring rod is graduated by a series of annular grooves ½ inch apart. The parts are the same as before and it is only necessary to unscrew the shoe, and replace with the base. Fig. 7, made in such a shape that it can be used in close shoulder work. This tool can be used as disk-gage, surface-gage, height-gage, etc., by placing the different parts in the split chuck and the machinist's needs may suggest various other uses to which these devices by slight changes may be made to apply.

* * *

THE DAVIS SELF-LOCKING CAM.

In the usual construction of mining stamps, used for crushing ore, the stamps are operated by double cams mounted upon a longitudinal horizontal shaft. These cams are made to give a free fall to the stamps, and are arranged on the shaft so that some are always lifting stamps while other stamps are falling, the reason, of course, being to equalize the driving power. Because of the shock and vibration it has been found very difficult, if not impossible, to keep these cams tight upon the driving shaft with any ordinary system of keying. Moreover, it is highly desirable that the cam can be easily removed as they wear out comparatively quickly and so have to be periodically renewed. For these reasons self-locking cams have found favor, the Blanton type being well-known. This is somewhat expensive in construction as special machinery is required to machine the locking surfaces which consist of a series of arcs arranged in sawtooth fashion. In the Davis self-locking cam, however, the construction is simpler.

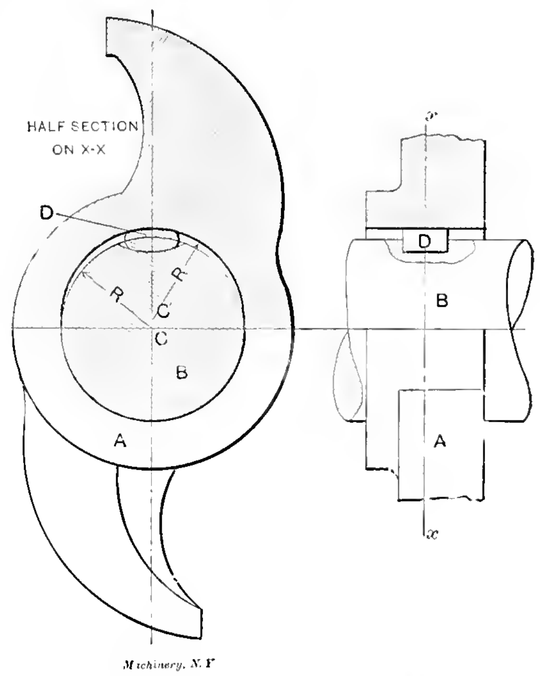


Fig. 1 Fig. 2.
Cam for Stamp Mills.

Referring to Figs. 1 and 2 which show side and end views with sections in each case, A is the cam, which, it will be observed, is double, that is, it lifts the stamp twice in a revolution; B is the shaft; and D is the key. After the cam has been bored to the radius R, it is set over and with the same radius an eccentric seat is bored in the middle of the bore and having a width about one-half that of the total length of the bore. This eccentric bore is shown in Fig. 1 by the radius R' drawn from the eccentric center C' and its width is indicated by the length of key in Fig. 2. A keyway is then cut through the bore somewhat wider than the key, and it is cut so that its bottom conforms to the arc of the eccentric bore. The key-seat in the shaft is milled with a cutter of the same radius as the shaft, and the key is made with its two working sides shaped to the common radius R. In assembling, the key is seated in the shaft and the cam is shoved on until the eccentric bore is directly over it; then a backward turn locks the cam on the shaft so that it can neither turn on the shaft nor slip endways. If the degree of eccentricity of the bore R' is correctly chosen the cam can be easily loosened by a blow on the point in the reverse direction.

* * *

An important ordinance has been passed by the Board of Aldermen of New York City, and is now in the Mayor's hands, requiring the use of fireproof wood in all buildings over 75 ft. in height and in all public buildings over 35 ft. in height.

LETTERS UPON PRACTICAL SUBJECTS.

A VACATION AND WHAT CAME OF IT.

Editor MACHINERY:

A friend of mine was telling me a while ago how he spent his vacation, and it was so interesting that I think that it will stand relating.

He was a toolmaker and he had worked steadily for over a year, and at the same time was taking a correspondence course in mechanical drawing. The hot weather was coming on and one night he came home and said to his roommate: "Bill, let's take a vacation." "Done," said Bill. "Where will we go?" "Denver," said Ed. "All right," replied Bill. And the next morning they "jacked up" their jobs, bought a first-class ticket for Denver and started.

They enjoyed the trip and arrived in Denver and took a room at a good hotel and the next morning started out to do the town. Ed. got a job at once in a small shop on the outskirts of the city engaged in tool and experimental work. His first job was making a die for a shoe heel. He had worked on the job about two or three days and was getting along first rate except he was handicapped for the want of tools, especially files. Ed. was working away using the stub end of a file next to the handle, which was the only place which had any cut left, when the foreman came along and said: "I've had all sorts of men working for me, but I believe that of the whole lot, you're the awkwardest hand with a file that I ever saw." They had a few words over it and the outcome of it was that Ed. got fired.

He went home to the hotel and was mad clean through. He, an A1 toolmaker and one of the best vise hands in St. Louis, had got fired out of that little one-horse shop because he did not know how to handle a file! He was still "chewing the rag" over it when Bill came home and he told him the whole story, and said: "That's the last day's work that I'll do in a machine shop for one year, for if I ain't got it in me to do something higher. I'll get along without."

The next morning he started out and made a tour of the draughting rooms and civil engineers' offices, and finally struck a place with a mining engineer at draughting, working under instructions and with the understanding that it was to be a short job only. He stayed there two months and finished the job; when he left he was given an extra week's salary in consideration of the good services rendered.

The next day after leaving the mining engineer's office he bought a camping outfit, including a woolen and a rubber blanket, packed them on his back and started up the line of a new railroad in course of construction, the name of which I am sorry to say I have forgotten. He got a lift of thirty miles on a gravel train and fifteen miles more on "shank's mare" brought him up with the tracklayers. He found that they were full handed and there was no show for a job there; but that the engineer of the surveying party, some thirty miles further up had sent back word he needed some axmen. That night he stayed in camp and was used finely, had a good supper and a clean bunk and the next morning shouldered his sack and started on.

Fifteen miles was the best that he could do in that day and that night he slept in the open, with a log for a pillow and the moonshine for a blanket. Getting an early start the next morning he came up with the surveying party about noon. He found the chief engineer and applied for a job. The chief looked him over, smiled and said: "You're a tenderfoot all right, but if you think you can learn to swing an ax I can give you a chance to try; the pay will be $30 a month."

Now, Ed. had been brought up on a farm and if there was any tool outside of a machine shop that he could handle well, it was an ax. After dinner he was given a good ax and started in. There was a good-natured grin on the faces of the crowd as the tenderfoot came out, and the first good-sized tree they came to, the boss, a big French Canadian, said: "You take him 'one side,' and 'take him one side' he did, and when the tree was down the boss said: "You one good man; I tink you have seen ax before."

That night the engineer came around and said: "We need an assistant to the transit man, and in the morning you take hold with him; the pay will be $45 a month." The next morning he started in with the transit man running the cross levels. He stayed at this two months, learning, as he said, more about angles than he ever knew before. The weather, getting too cold for comfort, he "jacked up" the job and left the engineer with mutual regret, and promise of $60 a month if he saw fit to come back in the spring.

He came back to Denver, put in a week of sight seeing and then back to St. Louis, where he struck a job as draughtsman in a mechanical engineer's office, and when I saw him had been there over a year, coming in at 8 o'clock in the morning and going out at 5, drawing a weekly salary instead of "pay" and wearing a boiled shirt with case hardened ends.

"And now," said he, "I've proved to myself that I can make a living outside of the shop, and I'm going back into it again as soon as I see a good chance. I may stand at the desk instead of the bench, but I'm not afraid but that I can fill the bill in either place."

Should this tale, as told by him stimulate any of the boys to take another step up the ladder, this will not have been written in vain, and they will have the best wishes of

A. P. PRESS.

THE PRACTICAL PERSPECTIVE.

Editor MACHINERY:

It is pretty safe to say that anyone who has ever made a drawing has wished at times to be able to show a piece in perspective; perhaps only a detail or possibly a whole machine or building, but the artistic or "true perspective" takes too much time and patience for the average draftsman. Men in the shop often express the wish, in language of varying intensity, that the drawing was made "so you could see what the thing really looks like." This is probably why many men like to work to "samples" rather than drawings.

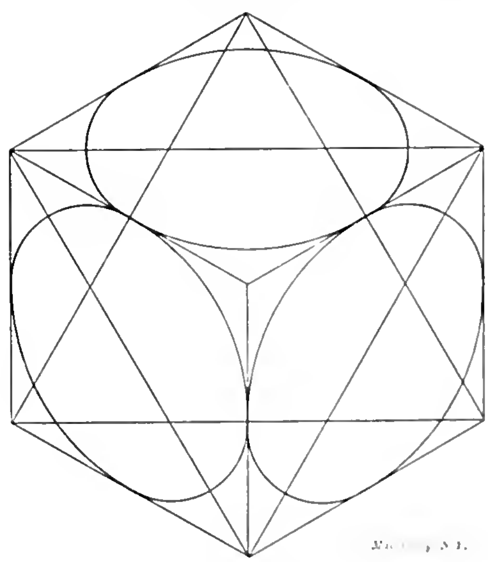


Fig. 1. Isometric Cube.

There seems to be only one practical way of using perspective, and that is what is called isometric projection. It was discovered or invented years ago, but has been about as hard to master as the true perspective and has not been made popular. In isometric projection lines which are normally horizontal are inclined 30 degrees from the horizontal in either direction, while vertical lines remain vertical. This makes a cube appear as a hexagon (see Fig. 1) and, as will be seen, makes the three visible sides "diamond" shape. These diamonds are the foundations for all circular work and as it is the circles which bother anyone in perspective drawing, a little attention to these will help make the matter clear.

All circles which lie in a horizontal plane and on which we look down when they are thrown into perspective, become ellipses in the upper diamond with the long axis horizontal. All circles or ends of shafts or tubes which run off to the left

have their ellipses in the right-hand diamond with the long axis, as shown. And all ends of round pieces which run off the right become ellipses in the left-hand diamonds. This holds true on all occasions and will help you out when you run up against something that seems hard to show or doesn't look quite right.

The wrench shown in Fig. 2 is an example of how often this works into sketches. With the handle going off to one side there is a great tendency to twist the ellipse around also—

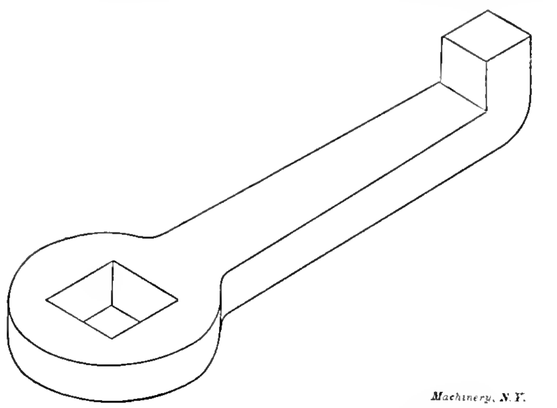


Fig. 2. Wrench in Isometric Projection.

seems as though it ought to be, but it is a top view and the ellipse remains as shown at the top of the square. To make this still more clear the spoked wheel in Fig. 3 is shown. Here the four spokes go in different directions but the central ellipse is horizontal just the same. This figure is made on a specially ruled paper so as to make it plain about the diamonds and to show how easy it is to draw with such guide lines. Where there are few curves the whole thing can be quickly done in freehand.

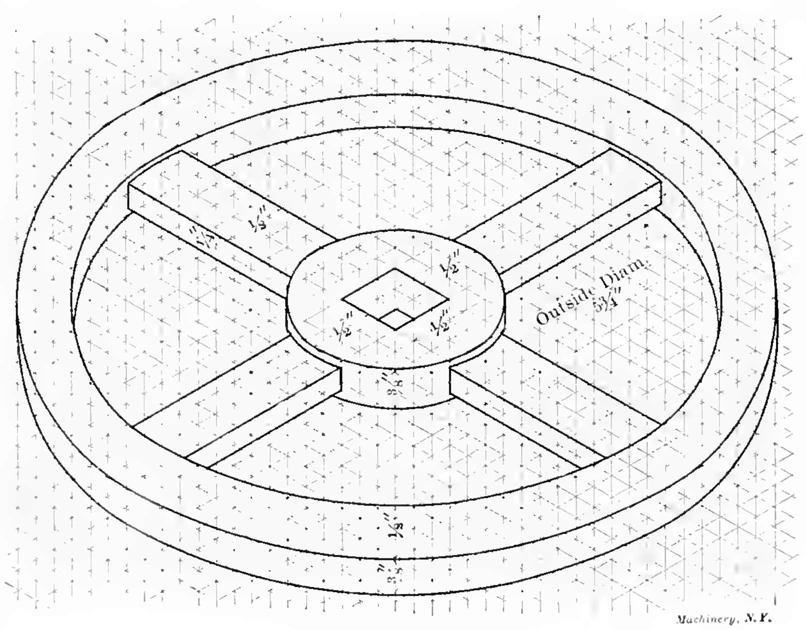


Fig. 3. Spoked Wheel Drawn on Isometric Paper.

Fig. 4 shows a rod end and gives an example of circles in the three positions. The broken end is in one position, the hole in the brass in a second, and the oil cup in a third. It might be thought that, as the rod is thrown up at an angle the oil cup circle should also be in that position, but such is not the case. A few trials will convince that this is right.

There is no question as to the value of this method for "assembly" drawings, even if details are made in the old way, but the details can be worked out in the same manner and are very easily understood. FRED H. COLVIN.

HIGH-SPEED STEEL IN THE MACHINE SHOP OF TO-DAY.

Editor MACHINERY:

This world is one of hustle and bustle, especially among us Americans. We are always looking around, trying to find a short cut to wealth. Now, how many of the manufacturing establishments of this country are really saving any money, in the way many of them handle the different brands of "high-speed steel"?

High speed steel has been before the manufacturing public for some time, but not until quite recently did it come into such general use and attract so much attention. It is, indeed, a great way to save money if handled by the people as it should be. It has great strength and can stand what no ordinary steel can stand. You can not pick up a mechanical journal to-day and not read of some of the marvels that have been accomplished with the "high speed steel." There is a great saving in time, but right here many close their eyes. Do they not save time at the expense of something more valuable by far? Right here starts the mistake.

A foreman in a machine shop will pick up a mechanical journal and read (if he reads one at all) of the great time saved by Blank Mfg. Co., of Somewhere. He will read it with amazement and perchance say to himself, "Well, now, is that possible? I will have to 'speed up' the men a little to keep in line with the rest of the world." He will come into the shop and start in on Tom. "Tom, throw that belt down on the high speed and put on a little heavier feed." So he will go around from one to the other. Then he struts around the shop with a self-satisfied grin on his face and tries to make the men feel that he is of some importance about the place. He thinks he has accomplished something of note. But has he? Did he, maybe, speed up his men more than their machines were capable of doing, and spoil the accuracy of the machine? Most of these tests are made on "high speed lathes," lathes that are especially constructed to stand the strain to which they are subjected. Lathes with long bearings, large driving belt, and heavy headstock spindle, and many other minor points that make them stronger than the average lathe. But you go into many shops and they are trying to make as good time on a lathe built fifteen years ago as they are on a modern lathe especially constructed for this work. They often succeed in making as good time on rough work, but when it comes down to accuracy of their job, then what do they have? You find that they have

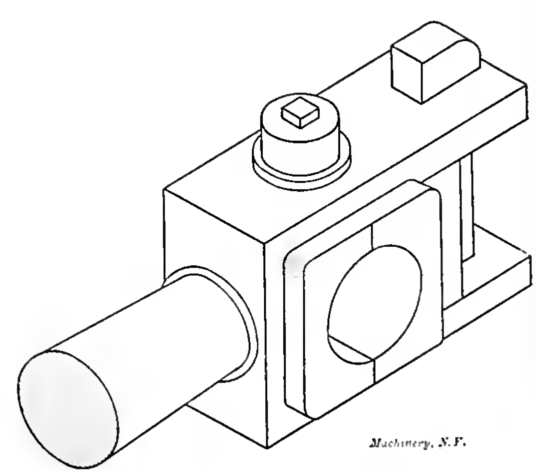


Fig. 4. Connecting-rod End.

sprung the lathe all out of shape; strained the leadscrew, and they have lost motion "to burn" all over the machine. You can not expect to compete in "hogging," with an old lathe as your "hog." This is not only the case with lathes, alone, but with all lines of machinery. The machinery in use to-day must be redesigned to meet the demands of the times.

If you broach this subject to many foremen and ask them how about the wear and tear on the machinery, they simply say that they do the work in so much better time that it makes up for this loss. But it does not, for the simple reason that they are straining every machine in the shop, and the work they do on the machines is not accurate. When it comes to assembling or when work goes to the vise hands, then they put in the time trying to make a job out of some fellow's "bum" work. But you can not do this and save time, so you see in this way you have a poorer lot of work turned out and a shop full of ruined machinery. You go into any shop in this

country that follows such methods and see if their force of vise hands has not increased faster than their force of machine hands, for the simple reason that they need more men to turn out the work in the same time, because the machine work is not properly done.

What is the natural consequences of such lax methods? Why in a short time your machinery does not represent the same standard that it once did, and your trade begins to fall off as a result.

Now to overcome this difficulty you must place a man in your shops at the head of affairs, that is practical, and can improve the methods of doing work, but not at the expense of the machine's accuracy. You want a man that can design special tools, etc., and in many little ways facilitate your progress. However, if you are able, financially, buy the best machinery and then try to keep abreast with the times, by employing skilled labor and employing the cheap labor for helpers. I do not think much of the management of a man that has to employ cheap labor to make a decent showing or profit for the business. I would not employ a foreman that is always trying to grind his men down to the very lowest wages.

The time is now at hand when a man must know a little about his business in a practical and theoretical way. If he does not, a man who does know steps in and takes his place, and he is pushed out in the cold. J. J. JENKINS

LATHE ATTACHMENT FOR TURNING TROLLEY WHEELS.

Editor MACHINERY:

The service required of trolley wheels, demands that they should be made of as hard a composition as can be machined at a reasonable rate of cost for the work. In the shop where this device for turning trolley wheels is used, this work was formerly done by the following method:

The hub in the casting had a cored hole which was first drilled out, and then reamed to size, the casting being held in a three-jaw chuck, and the work done in an engine lathe. One end of the hub was faced off, and the other end faced by a separate operation. After the hub was finished, the casting was then placed on an arbor, that fitted into the hole in the spindle of the lathe, and was held in position by a nut on the end of the arbor. A pointed lathe tool was then used to rough off the metal in the groove, the tool being made to follow as closely as possible the contour of the groove. After this operation was finished, a tool having the shape of the groove was used for finishing, it being held in the tool-post, the same as an ordinary lathe tool. The width of a trolley wheel is $1\frac{3}{8}$ inches, and the depth of the groove $\frac{3}{8}$ inch; from these dimensions it will be seen that the last tool had to take a cut that should have had a very substantial machine to do the work. Such was not the case, however, and the whole arrangement was very unsatisfactory. The margin of profit on this work is very small, and it will not pay to put in expensive machinery to do it, so the device described here was designed to do the work.

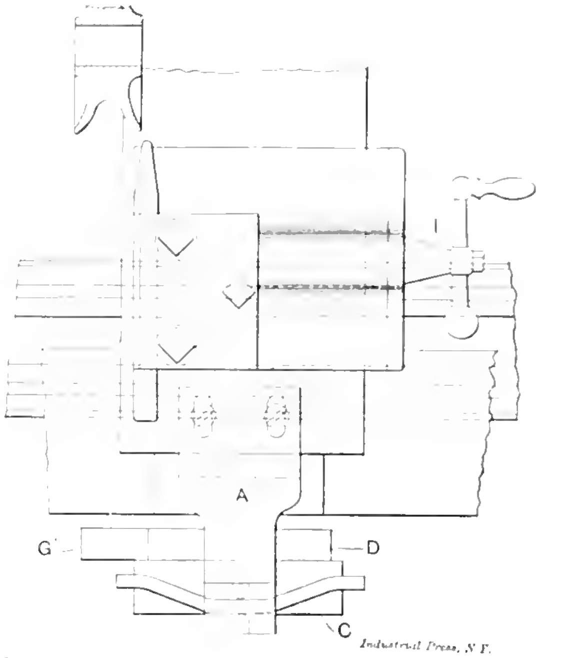


Fig. 2. Plan View of Attachment showing, also, the Tool and Work

The work of finishing the hub was transferred to a turret lathe, the casting being held in a two-jaw chuck, the jaws gripping it in the groove. The hole was bored, then reamed, and a tool having two cutters spaced the length of the hub, was then used for facing the hub; one cutter faced the side nearest the chuck and the other cutter the outside face. Thus the hub was finished with one chucking.

To turn the grooved part, the engine lathe before mentioned, was arranged to do the work with a round point tool, driven by a cam, so shaped as to give the curve desired. Fig. 1 shows a front view of the device with a portion of the apron of the lathe in sight. Fig. 3 shows a section of the device on the line x x, and also a portion of the lathe and some of the hidden parts of the feed mechanism. Fig. 2 is a top view, showing a portion of a trolley wheel in position and the tool

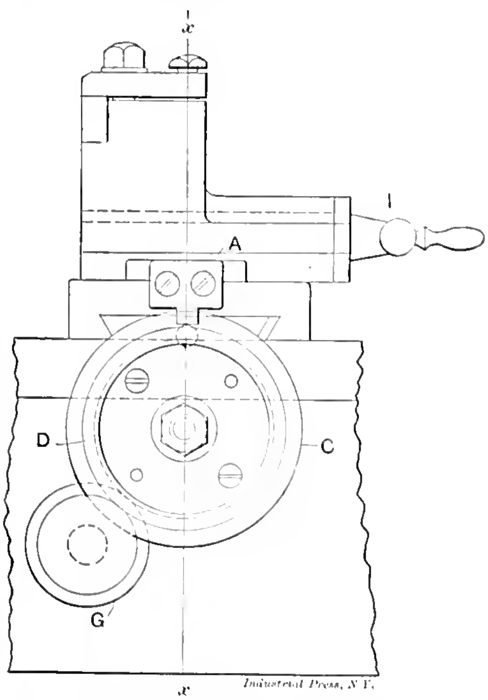


Fig. 1. Front View showing Circular Cam

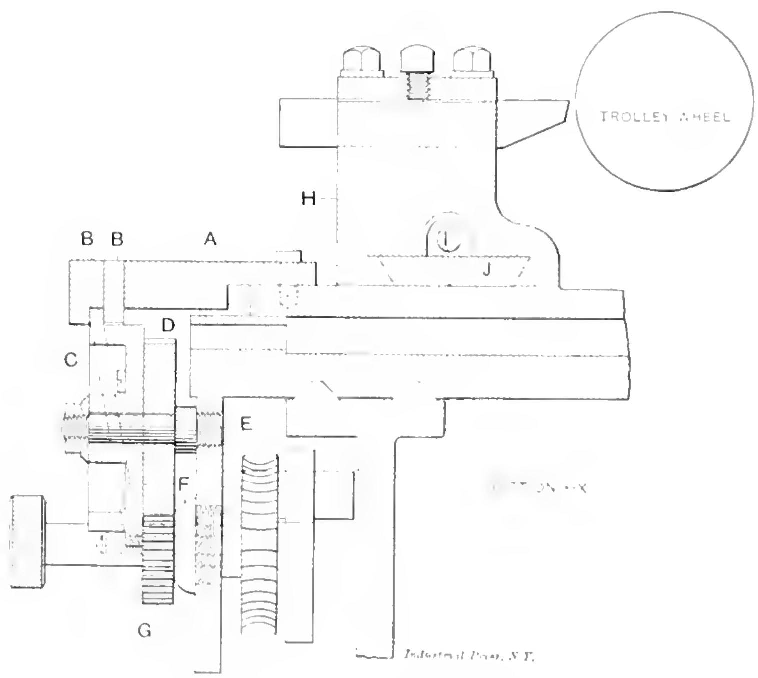


Fig. 3. Cross-section of Lathe Carriage and Cam Attachment

ready to take the cut. The cam *C* was fastened to a gear, and both revolved on a stud *E*, Fig. 3, which was screwed into the apron of the lathe. The sleeve *F* that supported the hub of the worm gear in the apron, was faced off to allow room for a gear *G*, the pitch diameter of which is shown. This gear was keyed to the hub of the worm gear, and, of course, revolved with it.

The cross-feed screw was removed and an extension, *A*, Figs. 1, 2 and 3, was fastened to the tool carriage in its place. Two hardened steel blocks, *B B*, Fig. 3, having carrying pins, were screwed and doweled to the extension. The pins of these blocks straddle the track of the cam. The cutting tool, of high-speed steel, was supported in a special holder *H*, whose

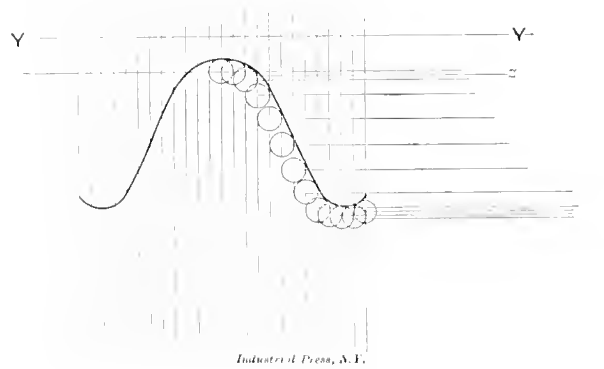


Fig. 4. Layout of Cam.

height was such as to bring the top edge of the tool to a point even with the lathe center. The holder *H* is adjustable laterally by the screw *I*, working in a nut which is fixed to the dovetail block *J*, Fig. 3. Adjustment for depth of cut is obtained by the slotted holes shown in the extension *A*, Fig. 2. This adjustment is but little used, the tools being ground and set to gage.

The construction of the lathe was such as to permit the adoption of this device, it having a feed reversing arrangement in the apron that, at the middle point, threw the gears out of mesh, and allowed the carriage to be run back freely after the cut was made. It was found that one turn of the worm gear gave an inch of movement of the tool carriage and as it was desired to have $1\frac{1}{2}$ inches movement to the carriage to one turn of the cam, the gears were arranged in the ratio of 1 to $1\frac{1}{2}$. The outside diameter of the cam track was made so as to give a circumference of 16 inches. This was done partly for the purpose of laying off the cam readily, and it may be of interest to some of your subscribers to read how this was done to give the curve desired.

This curve was taken from a sample wheel, to which a template was closely fitted and the curve was then plotted as in Fig. 4. Twenty-five vertical lines, giving 24 spaces of 1-16 inch each, were laid off on this curve, the middle line being in the center of the curve. The shape of the tool point was to be a semi-circle of 1-16 inch radius, and in order to obtain the curve the cam should make, circles $\frac{1}{8}$ inch diameter were drawn, the centers of which were in the vertical lines, and the sides just touching the curve. From the centers of the circles, horizontal lines were drawn, and a line *Y Y*, representing the back edge of the cam was drawn. The pattern for the cam was spaced on the face of the rim into 24 equal parts, giving a distance of $\frac{3}{4}$ inch for each space, or a ratio of distance of 12 to 1 of the cam and the curve. The width of the cam track was to be $\frac{3}{8}$ of an inch, so beginning at any one of these spaces and at the edge of the pattern, a circle $\frac{3}{8}$ inch in diameter was drawn. On both sides of this first circle and on the lines representing the spaces, two other circles of the same diameter were drawn, the distance from the edge of the pattern to the center of the circle being found by measuring the distance from the line *y-y* to the nearest line, *z*, drawn from the center of the circle representing the point of the tool in the diagram. This distance is quite small, and had to be measured carefully; in fact the whole diagram had to be laid out with great care. All the other center distances were found in the same manner as the last, and it only remained after this was done to draw lines from the edge of one circle, to the edge of the next circle, and so on around the pattern to complete the laying out of the track.

The whole device worked better than expected, the only weakness being the carrying pins *B B*, which wear faster than is desirable. The curve generated is so accurate that upon cutting a wheel into two parts the curved surfaces exactly matched. The strain on the lathe is reduced to a minimum and the work is rapidly done.

A simple device for truing the edge of the wheel was afterward added. This mechanism was supported by a bracket, fastened to the lathe head, and consisted of a tool carriage worked by a lever and carrying two tools, the whole device being on the back side of the lathe and out of the way.

J. R. Gordon.

Brooklyn, N. Y.

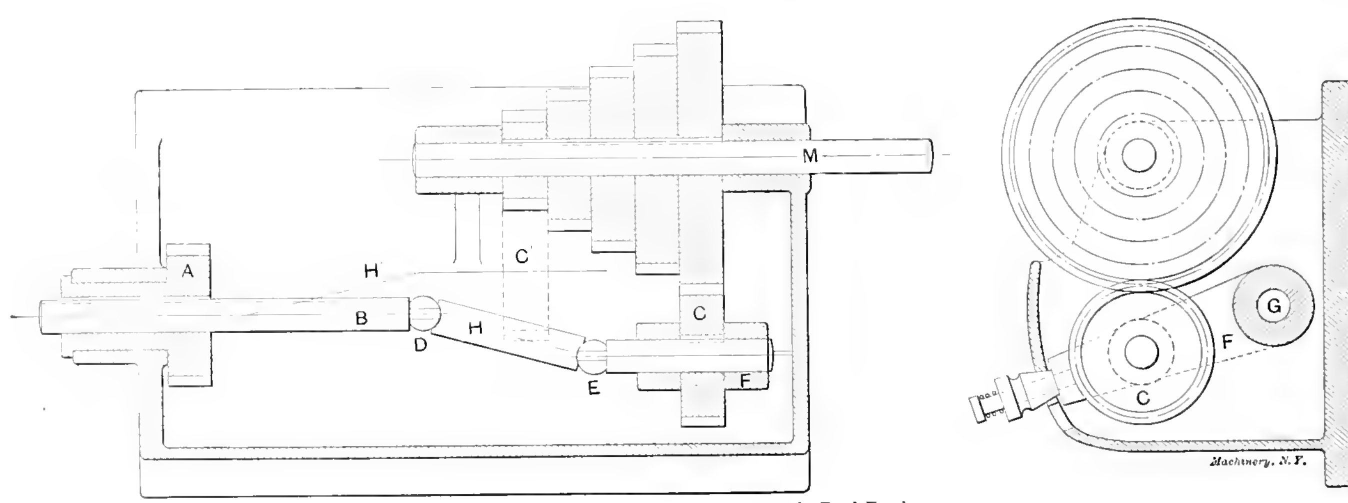
PROPOSED CHANGE GEAR DEVICE.

Editor Machinery:

As change gear devices seem to be the fashion about this time I offer the one shown in the cut as being a simple and effective method of getting a variety of positive speeds for tool feeds, screw cutting or machine drives. The drawing is almost self-explanatory. Gear *A* is the driving gear within which slides shaft *B*. Shaft *B* transmits its motion to gear *C* through the shaft containing two universal joints, *D* and *E*. Gear *C* is held in the forked rocker, *F*, sliding on a stationary rod, *G*. The rocker is held in its various positions by a spring catch acting in holes in the casing of the mechanism. Gear *C* may be brought into mesh successively with any one of the nest of gears on shaft *M* and so drives the shaft at corresponding speeds. For heavy service it might be better to have the diagonal shaft *H* made to telescope instead of having shaft *B* slide in the driving gear. *C′* and *H′* represent the position of *C* and *H* when driving the smallest gear on shaft *M*.

E. H. Fish.

Paxton, Mass.



Simple Device for Securing Changes in Tool Feeds.

LABOR-SAVING SCHEME FOR MAKING DRAWINGS.

Editor MACHINERY:

There is always more or less interest taken in a new labor-saving device, and no one is generally able to judge the importance of such improvements better than the designer himself, but seldom does the designer think of improving his own situation by devising a quick method of making drawings.

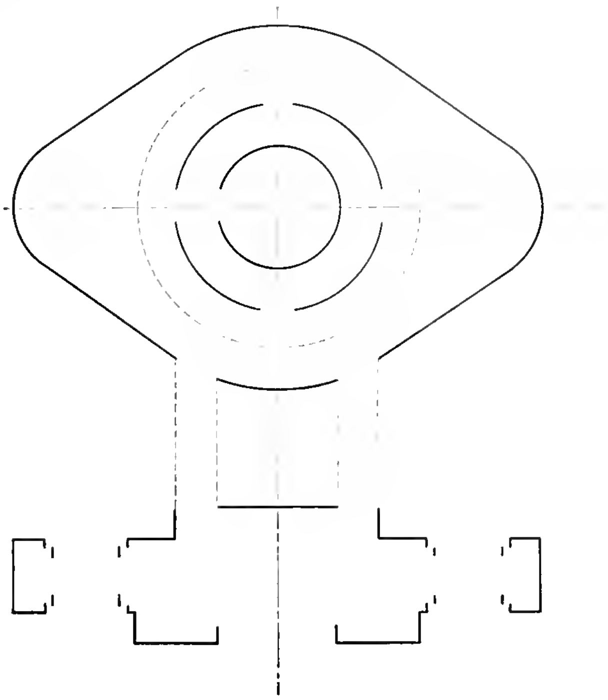


Fig. 1. Drawing Outlined by aid of a Templet.

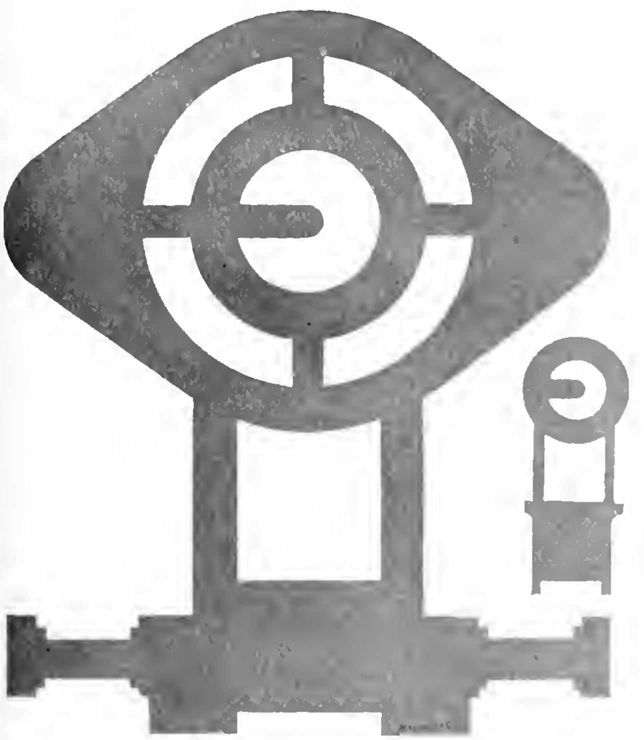


Fig 3. Templets used for making a large number of Drawings for Jigs.

A short time ago I developed a novel idea for making drawings of jigs for drilling glands and stuffing-boxes. The company I was working for had followed the practice of coring the stud holes in the glands, and after they were machined these glands were used as jigs for drilling the stuffing-box stud holes. The cored holes were not symmetrical, and could not be duplicated, so I was detailed to devise a cheap method of drilling these glands as they were to be cast blank henceforth. This style of gland jig may not be new, but I think the method of making the drawings has not been published.

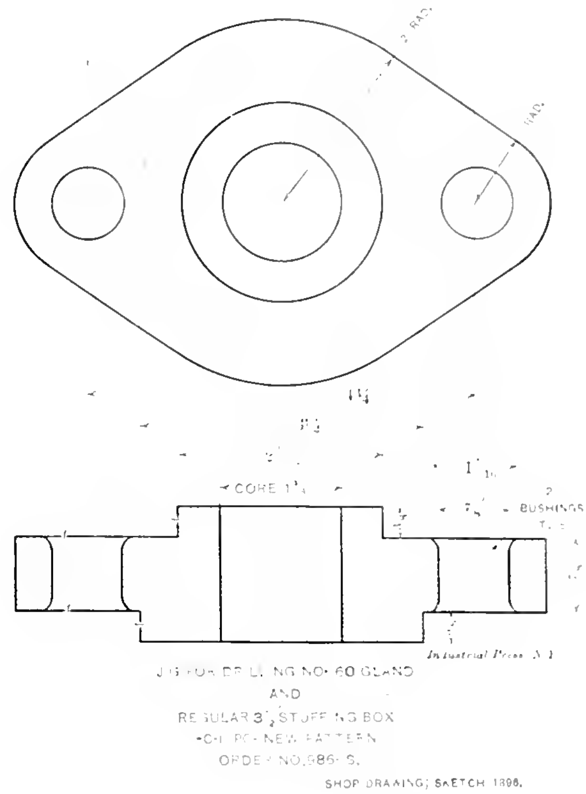


Fig. 2. Completed Drawing of Jig for Drilling Glands and Stuffing Boxes.

Fig. 2 shows the style of jig drawing with two counterbores, one for the gland on one side, and on the opposite side a counterbore for the stuffing box. In making this jig drawing I used the templet shown at Fig. 3. This was first drawn on cardboard and cut out as shown so that by tacking on a paper the outline could be made with a pencil as shown at Fig. 1, which is easily filled in to make it look like Fig. 2. The bushings in the jig are for drilling the gland. At the right in Fig. 3 is a templet for marking out a loose bushing shown in Fig. 4, first as marked out and second as finished. This bushing is used to put in jig for drilling the stud holes in stuffing-box head.

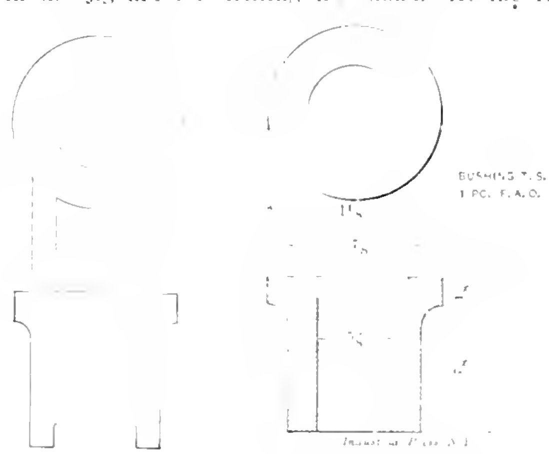


Fig. 4. Showing Drawing of Jig Bushings.

I found that by using carbon paper I could make four drawings at the same time, by placing four sheets of paper under the template with carbon paper in between each sheet. The pressure of the pencil would make an impression strong enough for my purpose. The figures of course I would leave out to be filled in according to the size desired of this style of gland. Some glands were round, some square, with from two

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C. W. PUTNAM was born in Orange, Mass., June 8, 1862. He served his apprenticeship with the New Home Sewing Machine Co., Orange, Mass., and is now with the Deane Steam Pump Co., Holyoke, Mass., where he is department foreman and designer of jigs and tools. His experience has been mostly in sewing machine manufacture and the building of pumps, both of which he considers as his specialties. Mr. Putnam has contributed a number of articles to the technical press on laying out work.

to four holes to be drilled. There being nearly 500 regular glands of different sizes to make jigs for, this method of making the drawings proved a great success. The drawings were not inked in or made to scale but the figures told the story.

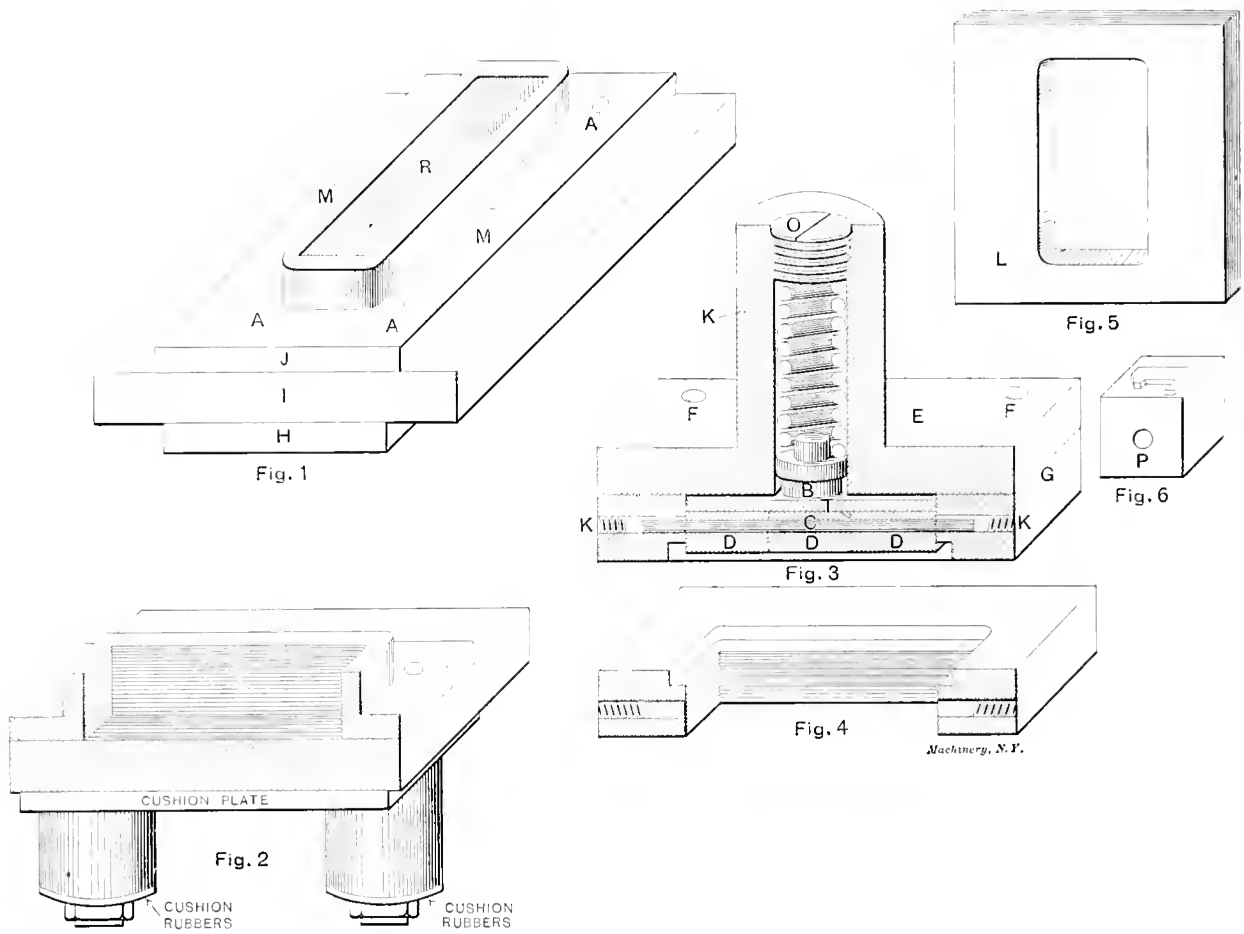
Holyoke, Mass. C. W. PUTNAM.

PUNCH AND DIE FOR MAKING NUMBER PLATES.

Editor MACHINERY:

The punch and die shown in Figs. 1 to 6 are for making number plates which are used to number stoves and to designate the different styles of a steel range made in our shop. I think it is quite a novel way of making number plates, and after I have described the die and its workings, I believe the readers of MACHINERY will agree with me, and I hope that it *I*, which is made to fit a 4-inch shoe, and held on the block *I* by the 5/8-inch fillister screws, *M*. *A* are cushion pin holes which work on the cushion plate *H*, to keep the metal from buckling while being formed. Fig. 2 shows a sectional view of Fig. 1 with the cushion rubbers in position. Fig. 5 shows the cushion ring, which is mortised out to the shape of the forming die, *J*, and sets on top of the four cushion pins, *A*. The metal is laid on top of the cushion ring, which projects above the top of the die about 1-16 inch, and as the ram descends it forces the cushion plate, *H*, down, and the tension of the cushion rubbers keeps the metal from buckling.

Fig. 3 shows a sectional view of the female part of the die. The upper half of the die *E* is made of cast-iron and a 3/4 inch hole is drilled through the shank for the spring *N*. Fig. 4 shows a sectional view of the lower half of the die, *G*, Fig. 3;



Views of Punch and Die for Stove Number Plates.

may be of some benefit to others who are engaged in this line of work.

J, Fig. 1, shows the forming die, and the number holder, as I call it, which is of hardened tool steel. The mortise *R* holds the number blocks, shown in Fig. 6, which are interchangeable, and is made to hold three blocks at a time. The number blocks are 11-16 inch × 11-16 inch, and are made of brass; by using two 11-32 inch pieces to make up for the third block, two numbers can be made on the number plate instead of three. The piece *J* is set on the cast-iron piece, it is made to conform to the shape of the forming die, *J*, Fig. 1, and is made twice the thickness of the metal larger. Fig. 3 shows the female number blocks, *D*, in position. These are held in place by the rod, *C*, the blocks having a hole 5-16 inch diameter drilled through them, as shown in Fig. 6, at *P*. The two screws, *K*, are to keep the rod *C* from coming out. These blocks act as a kicker, which accounts for the hole being drilled 5-16 inch in diameter, as the large size allows the blocks to work free and bottom on the upper half *E* or shank holder. The piece *T* is a loose piece laid on top of the blocks, *D*, so as to get even pressure on all of the blocks. The piece *B* rests on top of the piece *T*. As the width of the

Fig. 7. Number Plate as it leaves the Press.

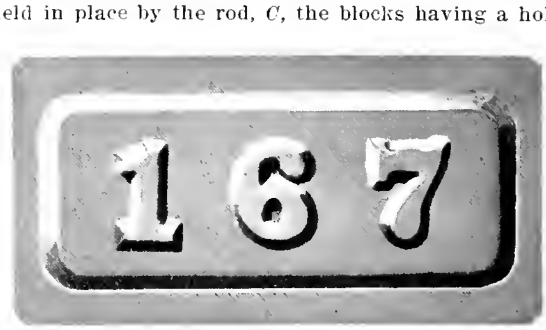


Fig 8. Plate after being Trimmed.

blocks is only 11-16 inch, I had to use this means of making an effective ejector, as the spring hole being ¾ inch in diameter it would not allow the spring to come in contact with the piece *T*. The lower half of the die *G* is fastened to the upper part by means of the four fillister screws, *F*. *O* is a tension plug and keeps the spring from coming out.

Fig. 9. From a Photograph of the Punch and Die.

One advantage of this die lies in having the numbers interchangeable; it only requires a few blocks, whereas if each number was all made in one, it would require a great many number blocks. Constructed this way it makes a very neat tool and produces just as good a work.

Lorain, Ohio. W. VAN ORMAN.

ADJUSTABLE HOLLOW MILL.

Editor MACHINERY:

I send below description of an adjustable hollow mill that can be used where the collar clamping device of the ordinary form is in the way. It was developed in our shops two years ago, and is the joint production of my foreman and myself.

Referring to Fig. 1, *A* is a machine steel shank fitted to the drill press or other machine in which it is to be used. It is threaded at *a* and the lower end is turned down so as to form

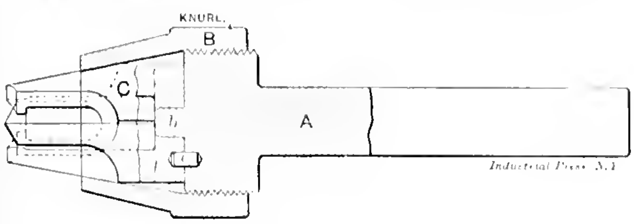


Fig. 1. Section of Hollow Mill.

the stud *b*. *B* is a collar or sleeve similar to those used on adjustable chucks for holding small drills. It is also of machine steel, is threaded to fit the shank *A*, and below the threaded portion is bored taper. *C* is the hollow mill of the ordinary split collar type, except that at the upper end it is bored to fit the stud *b* and a portion of the outside is turned taper to fit the collar or sleeve *B*. In the lower end of the shank *A* is inserted a driving pin *e*, which enters a hole *f* in the upper end of the mill *C*.

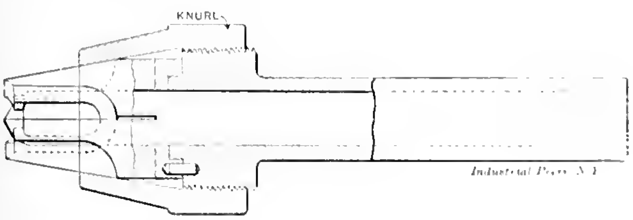


Fig 2. Hollow Mill for Long Work.

The above described tool can only be used for short work, but the modified form shown in Fig. 2 will take work of any length.

Our mills are made a trifle larger than the desired size and squeezed down by the taper collar *B*. This affords a delicate adjustment for size and at the same time keeps the teeth of the mill concentric with the shank. V. H. MARCELLUS.

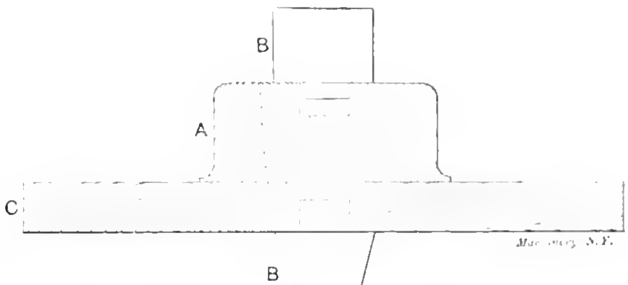
Belvidere, Ill.

PATTERNS FOR CHUCK PLATES.

Editor MACHINERY:

For a number of years we fitted up chuck plates in the same way that most other lathe builders did. That is, we hunted through all the patterns we had or our neighbors had at the foundry. After spending just about time enough to make a good pattern we tacked a couple of thicknesses of leather belt around the rim of one and used a hub that was a mile too big, but had about the right size core print, and trusted to luck to remember to turn the hub down a little. The principal variation from this method was when we found a hub about the right size but with a 2-inch print where we wanted a 1½-inch core set. The molder usually got it near enough the middle so that we could use it except when we were in a great hurry.

We finally rebelled and got out a set of patterns that worked well enough so that the other lathe builders were perfectly willing to borrow them. We turned up a set of hubs as at *A* in the cut, making the diameter of the hub about 1¾ times



Pattern for Chuck Plate.

the diameter of the nose of the spindle it was intended for. These hubs had a dowel made on one side 1 inch in diameter, as shown, and on the other side a corresponding hole. Sets of core prints were also made of sizes to correspond to the standard foundry stock cores and of a size to allow about ⅛ inch on a side to bore out before threading. These core prints were all made with 1-inch dowels, as shown, and were stamped plainly with their actual size and the size lathe for which they were intended. The hubs also were stamped with the lathe sizes. The plates *C* were made to suit the diameters of plate called for by the makers, whose chucks we were mostly using, and were stamped with their finishing sizes, that is, the size they were intended to finish to. The thickness of the plates varies from one-eighth of the diameter for small plates to one-twelfth for plates a foot or more in diameter.

A full set of hubs and core prints was made at once and a few of the most used sizes of plates. After that if a new size was called for it was a matter of only a very short time to get out a new plate. E. H. FISH.

Paxton, Mass.

ACCURATE JIG MAKING.

Editor MACHINERY:

Kindly allow me space for a few words regarding accurate jig making. I was somewhat surprised to note in the current issue of MACHINERY that Mr. J. R. Gordon prefers a drill press to either the milling machine or button method for accurately spacing holes. Undoubtedly brother Gordon failed to state how he overcame the following unquestionable chances of errors, and I will point out where the drill press is not allowable for jig making in watch or fine instrument factories. When writing the article on jig making in the July issue, I had in mind the method of spacing as advocated by Mr. Gordon; in fact, I described that same method applicable to the lathe in the January, 1904, issue of MACHINERY, but it is accurate only when holes are *bored*. Let us see how many chances for error are presented when employing the drill press plan of spacing. First, the bracket or arm, that is fastened to drill press and which holds the bushings used to guide the drills must be made perfectly accurate; that is, the hole in said bracket must align absolutely with center of drill spindle. Secondly, the bushings to guide drills must be made so that the hole is perfectly concentric with the outside. Third, the hole in bushing must fit perfectly the drill used. Fourth, the outside of bushing must fit perfectly the hole in bracket, to insure the hole in bushing remaining absolutely central with spindle when using bushings with different sized holes. Fifth, the spindle of drill press must be at right angles with table of press in every direction, a condition that is rarely met with in a drill press.

Mr. Gordon spots the holes using spacers made of drill rod. The bracket is removed and the holes drilled clear through the jig plate. But what assurance has he that the drill continued through the plate perfectly straight? None whatever; hence, chance for error No. 6. When drilling work fastened to face plate of lathe we always bore the hole to "true" same. Now, why will a sensitive drill press, that is more sensitive to "spring" than anything else, produce a hole that requires no boring? Seventh chance for an error is when the holes are opened up with a half-round center reamer having but one cutting point. Cast iron is full of grit and it requires but a small particle of grit to cause the center reamer to change its location. Eighth, and greatest chance is that of opening the holes with a larger drill. If one lip of drill is the least bit longer than the other it is therefore doing more work and tends to crowd the drill over to opposite side. Error No. 9 is when the hole is sized with a reamer. I repeat my statement made in August issue of MACHINERY, that when absolute accuracy is required, the hole must be bored. Error No. 10 is the personal one, caused by uneven tension on measuring instrument when making the drill rod spacers. True, the error in all cases may be very slight, but if there are, say, 20 holes in the jig, the multiplication of errors will amount to considerable. It is very doubtful if a jig, made in above stated manner, could be duplicated. When using the buttons for spacing as I described in the July issue there is but one chance of an error and that is the personal one caused by uneven tension on measuring instrument, due to the fact that the buttons are indicated and holes bored. Mr. Gordon meets this same personal error when making his spacers. I agree fully with Mr. Gordon as regards the condition of milling machines in most factories. But I stated very clearly that the milling machine method was applicable only to those being fitted with corrected screws and dials. Any manufacturer that holds accuracy in the tool room as the prime factor, and also expends $125 for three milling machine screws is very careful that a "cut meter" is not employed on that miller and reserves same for "Accurate Jig Making."

Gt. Barrington, Mass. FRANK E. SHAILOR.

SETTING FOR TURNING TAPERS.

Editor MACHINERY:

The following method for tapers may be of interest to some of the readers of MACHINERY; they have been of use to me many times:

When turning a rod to a certain given taper, or to fit a taper hole, if the taper is given, for instance, 5/8 inch taper per foot, and the piece is an odd length, say, 31 inches, instead of figuring the distance necessary for 31 inches of length I simply set the tool at a point 2 feet from the live center and adjust the cutting edge to a distance 5/8 inch from the work. This I usually do by taking a piece of 5/8-inch steel and set the tool so that it will pass between it and the work. I then set the tail center over so that the work will touch the tool. This gives the desired taper very easily, even if the rod is three or four feet in length.

If the hole to be fitted is, for instance, 5-32 inch taper to 3¼ inches in length, take, say, $8 \times 3\frac{1}{4}$ inches $= 26$ inches and $8 \times 5\text{-}32 = 1\frac{1}{4}$ inches. The distance necessary to throw the tailstock would be one-half of 1¼ or 5/8 inch measured from the end of the setting tool at a point 26 inches from the live center.

To bore a hole to a given taper with a compound rest I usually set a piece of shaft, rod or mandrel by this method and then adjusted the compound rest to the arbor with a tool set at the same height as the center for a guide. It is much easier than to cut and try, or to set to certain degrees by use of a bevel. I have worked in many small shops where the taper attachment was an unknown quantity and there the method just described is most valuable. J. T.

* * *

The air-lubricated journal, described by Mr. A. W. Cole in our issue of May, 1904, was designed and built by Prof. Albert Kingsbury and was used by him in his experiments on the theory of lubrication.

THE APPRENTICESHIP QUESTION.

The trade schools, night schools and the engineering shops do what they attempt to do all right, but do not fill the shop requirements. Boys become students in the trade schools because in many cases that is the best they can do. Learning to fit pieces of wood together in different shapes or in all shapes will not train a boy to be a carpenter and joiner, or patternmaker; chipping and filing, turning and planing, milling and drilling, and scraping will not make a machinist nor learning to make drawings of buildings make an architect.

Neither is it possible to make an architect in the way I believe it possible to make a machinist, patternmaker, molder, plumber, etc. They do not pretend to make architects in the trade schools any more than I would pretend to make mechanical engineers in the school of trades. They do come very near making brick masons at the Jewish school at New York by the trade school methods. That is to say that brick walls are built as they would be in a building by the students and then torn down to be built up in some other way by other students. Plumbing is taught similarly, that is, pipe can be screwed together and unscrewed to be used over, and lead pipe can be soldered and unsoldered, and for those two trades it is unquestionably a fairly good way.

But that way will not do very well for a foundry and not at all for patternmaking or machine work. In patternmaking the thing done must be good enough to use or it is practically a total loss and in a machine it is the same in the main. The different parts done in most of the college shops are simple exercises, pieces chipped and filed in some instructive form to drill the hand in special skill, and the work when done thrown into the scrap heap. Other exercises are in the use of the various machines, attention being directed to how the work is done, rather than to the ultimate use of the piece. Just whether this is the best method for the mechanical engineer it is not my purpose to discuss, but that such a method would not make draftsmen, patternmakers, molders and machinists, I am quite sure.

To make good foundrymen the boy must work where castings are made to be used and where the cost of the product is an important part considered, and this is the weak part of the college foundry. In the school pattern shop the cost of the work is much less likely to be considered than in the foundry or machine shop, as it is in all shops where the three are carried along together in the same establishment. In the new order of things where patternmakers are carrying on business and competing with each other the question of cost is brought down immensely by competition, and in many cases this is carried to such an extreme as to result in poor work, and one of the hardest things to teach patternmakers is to consider the ultimate use of the pattern. The poor patternmaker cannot make a pattern that needs to be good, good enough, and it is hard to get a patternmaker who is used to making good patterns to turn out a pattern from which only one or two castings are to be made, crude enough. In a patternmaking school this could easily be made a part of the training.

If one is to learn to be a machinist he must work where machines are made, and, too, where many kinds are made. To get this varied experience it takes the apprentice and young mechanic many years of time, and generally going from place to place. Whereas in a school this varied experience could not only be obtained at one place but in much less time.

In the ordinary shop, in fact in all shops, except in those cases such as Brown & Sharpe's, where a special instructor is employed, the apprentice has to acquire the trade by absorption, as it is no one's business to instruct him. He gains his knowledge by what he can see, and the bad habits, negligent and indifferent ways and methods are as easily absorbed as the good ones, and the progress at best is slow.

Where the whole business of the boy would be to learn and the primary business of the foreman to teach, and to teach the best known ways, a year or two's time would be added to the useful life of the man and the money value of this year or two's time saved would far more than pay the young man to

Paper read by Prof. John E. Sweet before the Syracuse Metal Trades Association, July 22, 1904.

work for nothing for three years than to be paid apprenticeship wages in the ordinary shop, though the primary trouble is, he cannot find the places to learn the trade even in the present indifferent way.

In reply to the prevalent notion that a boy cannot learn a trade in school, let us see if we can tell why the following plan would not work. Take a well-organized shop with all the tools and machines necessary to do various kinds of foundry, pattern and machine work, with drafting room, offices, etc., and I would add a school room, not particularly different otherwise from a regular shop except there shall be no dividends or taxes to pay. The running expenses for the first year would be insurance, coal, water, oil and engineer for power, material and general supplies, a small office force, foreman and instructors or journeymen, a sweeper and watchman and a very little in the way of helper, as that would be as in an ordinary shop, only much more largely so, done by the freshmen. Now the first year it would be too much to expect the enterprise to be self-sustaining, but the second year a change for the better could not help but show itself. Such of the boys as had not fallen out would have a year's experience and some of them would in certain ways be, by their superior opportunities, pretty good journeymen, and replace some of the hired journeymen of the year before. Some would have shown their ability for draftsmen, some office men, some foundrymen, some patternmakers and others machinists and likely some more drop out.

The third year still more of the employed help could be dispensed with, better and more difficult work intrusted to the students, those showing the ability set to doing the drawing and so learn the relation between the drawings, patterns and finished work. Some set at tool-making and those few that show the ability, inclination and have the means, started in the necessary preparatory work to enable them to enter the College of Mechanical Engineering. In this respect the school would become the sorting ground for the university.

The fourth year men would be enabled to fill nearly every place in the institution. The history of our times show that of those who learn the machinist's trade many make machinists, some make stationary engineers, some draftsmen, some clerks, some business men and some mechanical engineers, and this combination is exactly the combination that it takes with the patternmakers and founders to run a successful shop, and that is exactly what the successful school for apprentices has got to be.

The question naturally arises what is to be made to sell that will sell for enough to pay running expenses? At first such things as require the least expense for material and furnish the most work, as the work in the main will cost nothing, no matter how much of it is put upon a piece, if the piece will sell. Later better and better work could be done and as the final test will be the character of the men turned out, the best men can only be made by doing the best work. If better work is turned out than anywhere else, then the ordinary shops cannot complain that the school shop interferes with trades union labor.

As I have indicated a school room, that implies some school work that could be imparted in two hours a day, and of just the kind that would be of the greatest use to the mechanic or necessary to enter a technical school. Certain things such as writing, spelling, arithmetic and the civilities of life should be insisted upon, and beyond that such as the ability of the student seemed to justify.

When the school turns out men that there is a demand for, the reputation of the school would soon be such that the boys would covet the chance to be given admission and many parents willing to pay tuition fees, the same as at college. But after all would it pay dividends, taxes and insurance? No. Does it pay young men to go to college? Well, some it does and some it does not. Does it pay to go to school? Sometimes it does and sometimes it does not. Does it pay to learn a trade? Generally, and it is one of the best ways to keep men out of State's prison and the poorhouse.

But how is the fanciful school I have been describing to be brought about? It isn't in my time, but I hope in some of yours. Such changes before they materialize have to be harped upon by some man for about twenty years, then if he gets some one to help pick the harp strings with him the idea will grow, and in this case slowly, because it not only requires a change in sentiment, but money.

I can see no hope until the happy coincidence comes about by there being a good machine shop in the receivers' hands and the time when the glory of giving money to colleges, libraries and hospitals has grown stale, and the millionaire buys the shop, donates and endows it for the purpose.

What interest is all this to this association? First, to keep the supply of good workmen up to the demand, and second, to bring up a set of better educated men and further to fortify manufacturers against labor troubles.

It may be easily imagined that I am laying unnecessary stress upon the importance of the machine shop to our lives, but if we stop to consider one prominent fact it will be seen that we must have the machine shop or go back to primitive methods, as the machine shop is growing of more and more importance.

Everything is being done more and more by machinery and that means more and more shops to build them in. The technical schools are training engineers and men to lead, but it takes from ten to a hundred men to execute the work of an engineer, and nothing is being done, or certainly less and less is being done, to train them. Unless not only one but hundreds of such schools as I have described are provided, foreign workmen will find work in this country and promote idleness in our own young men.

If the old apprenticeship system is revived it can only be done by change in sentiment as to the relative value of an academic education and a trade. Whether it is of more value, and whether it is more likely to lead to happiness for one to know what has been done in the world or for one to know how to do something himself, will be the question. When a parent comes to the conclusion that he wants his son to learn a trade and is willing to pay the price, manufacturers will be willing to accept the money and give the boy a chance, or there will be money enough drifting the right way to establish the schools.

* * *

Compressed air is widely used on railways for cleaning the cushions, carpets, draperies, etc., of passenger cars, and it has been found far superior to the beater, broom and duster method. But it has one serious fault in common with the ordinary implements of cleaning in that it scatters the dust through the air, which, as soon as the disturbance has ceased, settles again upon the furnishings. For this reason the vacuum system of cleaning seems likely to supplant compressed air for railway car cleaning, and because of its great efficiency it is also likely to be largely employed for the annual or semi-annual "housecleaning" in hotels, private houses, etc. With the vacuum system everything is cleaned *in situ*, there being no need of taking down curtains or pulling up carpets. The dust is sucked out of them, even that which has penetrated carpets and lies on the floor beneath. The vacuum system, of course, requires a vacuum pump, or, in other words, an air-compressor in which the suction is the "business end" instead of the discharge pipe. For house-to-house work a portable plant is necessary, and the business has already reached the point of development in this country where the portable plants are being introduced. One recently built in New York consists of an inclosed electric automobile truck, in which is a three-cylinder gasoline engine connected to a small dynamo. This dynamo charges the storage batteries, from which current is drawn for running the truck and for operating the vacuum pump. This latter is in the back of the car and is driven by a small motor connected by a Renold chain drive. The pump is a vertical two-cylinder machine, having a capacity of about 400 cubic feet of free air per minute.

* * *

Three thousand employees will be required to operate the trains of the New York subway when it is opened next month, and most of them will require special instruction to qualify for the work. The arrangements for giving this instruction are so complete, that it is expected all the trains will be running on schedule time within an hour-and-a-half from the time the subway is opened to the public.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

We have received the following inquiries from our subscribers, which we are glad to submit to our readers as subjects upon which some among them may be able to supply information that will be of general interest:

1. W. C. J.—Will you kindly tell me how axes and hatchets are made, especially as to the way in which they are finished and tempered?

2. C. K.—Will you kindly inform me of the best prescription for thinning lard oil after it gets thick from using?

3. H. J. N.—Can you give me any information regarding the use of aluminum for gas or gasoline engine castings? Can it be used for cylinders, and, if so, of what composition should the alloy be? Also, can an aluminum mixture be used for the bedplate? The engine in question is for a gasoline launch to develop from 10 to 15 horse power.

4. B. and R.—Is there any means for protecting highly polished steel surfaces from rusting after soldering? We have tried several so-called anti-acid soldering solutions, but none of them prevented the subsequent rusting of the polished surfaces coming in contact with them.

5. "Connecticut" asks: Will you give me some idea in regard to making a straightener for brass wire 1-16 inch diameter? The wire has considerable spring in it. I have tried an eight-wheel straightening machine, but it does not accomplish the work desired. I do not want to mark the wire.

6. Inquirer: Can you give me information upon designing an 8, 10 or 12-tooth cast-iron sprocket wheel, for No. 32 malleable chain? I would like to have dimensions for the addendum, dedendum, thickness of tooth, clearance, etc.

Answers to Question 33.

The two following replies to the inquiry of C. W. B. for a solution or solder for soldering brass and steel together without rusting, have been received:

1.—Non-corrosive soldering fluid.—Grain alcohol, 3 pints; glycerine, ½ pound; chloride of zinc, ¼ pound. Glycerine to be well shaken or mixed with the alcohol before introducing chloride of zinc. After introducing the zinc to the alcohol-glycerine compound, mix thoroughly by shaking until the chloride is dissolved. Any combination of quantity may be used if the proportion is maintained.

2.—A saturated solution of chemically pure zinc chloride in best grain alcohol will give good results. It is equally good for copper.

About Sepia and Blue-print Paper.

We have two inquiries regarding sepia and blue-print papers. The first correspondent incloses a sample of sepia paper and asks, "Will you kindly advise me, if possible, as to what composes the solution used in making sepia printing paper? Also, whether there is any solution that can be used for making corrections on such paper?"

This inquiry was referred to our contributor, Mr. W. H. Sargent, chief draftsman of the Fairbanks Scale Works, St. Johnsbury, Vt., who replies as follows:

I regret that I cannot give you the formula for preparing "sepia paper" or "maduro paper" as it is sometimes called. It appears to me to be similar to "Kallitype" paper, described in the *Camera* for May, 1903 (The Camera Pub. Co., 114-120 So. 7th St., Philadelphia), also described in *The Photo Miniature* No. 47, Tennant & Ward, 287 Fourth Ave., N. Y. City. So much depends upon the selection of the paper and the preparation of the chemicals that the work of an amateur is likely to be unsatisfactory.

The sepia paper may be written upon with "Farmers' Solution," which consists of a few grains of red prussiate of potash (potass. ferryicyanide) with an equal amount of hyposulphite of soda. Pulverize the crystals and dissolve in an ounce of water. The proportions are not very exact—the stronger the solution the quicker it acts. The potash is very poisonous.

The second inquiry relates to making prints from, or reproducing blue-prints. As we have seen work of this character at the works of the New Britain Machine Co., New Britain, Conn., we submitted the inquiry to them and have the reply, which follows. These two inquiries and information given may, we trust, lead to information from other sources upon these subjects, which are of considerable interest to draftsmen.

With regard to reproducing blue-prints, we would state that we get out a considerable number of bulletin blue-prints consisting of part drawings and part type-written work. The foundation for these is a reversed blue-print made from a Vandyke process paper negative. This Vandyke process, as you undoubtedly know, is exploited by Eugene Dietzgen & Co., New York and Chicago. It was invented by a draftsman of ours, Mr. Schmelz, and gives a deep Vandyke brown background with white lines, and, of course, in reprinting from them with ferro prussiate paper, one gets blue lines with white background. A bulletin mailed you was made from a glass negative made by a wet process plate, by photographing a combined sheet of drawing and type-written work—the latter made with black record ribbon.

7. A. J. J. and others—We cannot understand the use of the expanding nozzle in the De Laval steam turbine. It would seem quite useless to generate steam of high pressure and then expand it idly before delivering it to the wheel. Why not use a straight nozzle and simply limit the boiler pressure in the first instance? 2. Why is it that steam when flowing through a straight nozzle superheats, while when flowing through a diverging nozzle, as that of the De Laval turbine, it condenses?

A.—It is necessary to expand the steam in order to get the full amount of work out of the steam that it is capable of performing. There is a large amount of stored heat energy in steam which can be converted into useful mechanical work even when the steam has been cut off entirely from the boiler; and it is this energy which is made use of by expanding the steam. In the case of a steam engine, steam is cut off in the early part of the stroke, but it continues to push the piston forward with a gradually lessening force, in virtue of its own intrinsic energy, which causes it to expand. In the case of a direct-acting pump, steam is admitted during the whole of the stroke. Practically considered, there is no expansion at all, with the result that this is one of the most wasteful forms of motors. In order to take full advantage of this expansive force in a steam nozzle the walls of the nozzle must diverge, as can be explained by reference to Figs. 1 and 2. It has been proven by many experiments that when a converging or straight nozzle is employed, like in Fig. 1, steam will expand in the nozzle to about 6-10 of the boiler pressure, under ordinary circumstances. This is true whether the boiler pressure is high or low. The result is that when the steam leaves the nozzle it at once drops the other 4-10 in pressure, and the jet of steam at once expands to a larger diameter, and its energy is dissipated in producing eddy currents, and in friction, instead of giving the steam velocity.

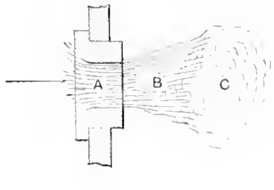


Fig. 1.

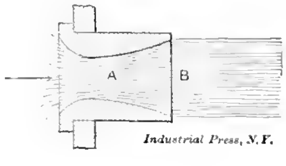


Fig. 2.

In Fig. 1 the pressure at A would be about 6-10 of the higher pressure, and at B is shown how the jet bulges out and how its energy is lost to a certain extent. Steam flowing through such a nozzle acquires a velocity of from 1,400 to 1,500 feet per second, this velocity being nearly constant for all pressures within certain limits. If, however, we attach a diverging mouthpiece to the nozzle, as in Fig. 2, having the area increase from A to B just sufficient to confine the steam so that it will be compelled to expand in the direction in which it is flowing, instead of radially, the energy will all be directed to giving velocity in the direction of flow, and the steam will issue in parallel lines at a much higher rate of velocity, which rate will increase with an increase in pressure in the boiler.

The reason the nozzle must diverge in order to produce this result is because steam at a low pressure has a greater volume

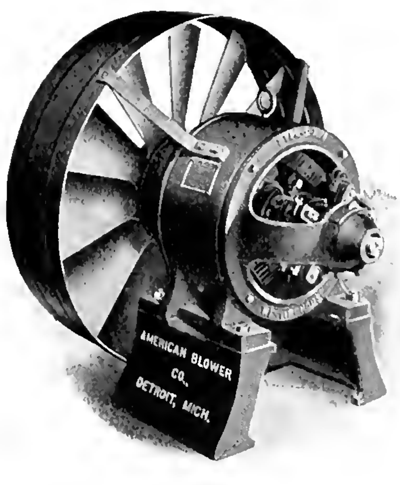
than steam at a high pressure; and consequently increasing room must be given it if the pressure is to drop within the confines of the nozzle. The flare of the nozzle is modified somewhat, however, by the fact that the velocity of the steam is rapidly increasing and consequently the steam gets out of the way faster toward the discharge end of the nozzle and the area at that point can be proportionately smaller than if this were not the case. Theoretically, the ratio of the areas at A and B, Fig. 2, should be directly as the specific volume of the steam at these two points (remembering that the volume at A must be for steam at 6-10 of the higher pressure) and inversely as the velocity of the steam at these points.

2. The answer to your second question must be evident from an examination of Figs. 1 and 2. In Fig. 1 the energy of the steam is dissipated in friction, and eddy currents, which produce heat and superheat the steam. With a diverging nozzle, however, the steam flows smoothly from the higher to the lower pressure, and all of its stored energy is converted into kinetic energy (the energy of motion). The high velocity of the steam in this case is the direct result of the expenditure of the stored energy in the steam, and inasmuch as this energy has been given up the steam has lost part of its heat and consequently has condensed.

* * *

VENTILATING BLOWER WITH MOTOR.

The American Blower Co., Detroit, Mich., have worked out a new design for diréct-connected disk fans, as shown in the accompanying illustration. The fan is a modification of the "A B C" fan of this company's make, which has been on the market for a long while and is in general use. The custom has previously been to attach the motor to the arms of the fan, but the excessive weight of the overhung motor has



sometimes been an objection. In the present combination the motor is placed on a substantial base, and the fan is supported by the motor frame by means of radial arms, as shown. The fan, which can readily be made very light in weight, is thus the overhung part of the apparatus. There are no bearings except those of the motor. The complete apparatus is compact and well adapted for ventilating purposes. The fan is equipped with Westinghouse motor.

* * *

IMPROVED DRAFT GAGE.

The importance of being able to tell the chimney draft at a glance is fully recognized, and the necessity of knowing the pressures maintained, where quantities of air are moved is becoming more apparent to ventilating engineers. In testing gas engines for their thermal efficiency, the pressure of the gas as well as the barometer readings must be accurately recorded if correct results are desired.

For such purposes an ordinary U-shaped glass tube has been used and the difference of the level of the liquid in the two legs taken as the pressure. Aside from the fact that one can seldom read closer than ¼ of an inch on account of the menisci varying with the direction of movement of the liquid and that one must take two readings and add or subtract to get the correct result and that the tube is fragile and often gets broken, the device gives good results.

In order to read closer than ¼ of an inch, a glass tube has been used in an inclined position, giving a 10-inch travel for 1-inch rise. This makes the readings finer but limits the range for practical purposes as a tube showing a difference of pressure of 6 inches would be five feet long.

To meet the requirements for a strong, direct-reading manometer that would give close results and could be used either as a portable instrument or could be attached to the gage board, an interesting draft gage has been brought out by Mr. C. E. Sargent, mechanical engineer, Chicago, and is for sale by Schaeffer & Budenberg, New York and Chicago.

It consists of a nickel-brass cylinder, closed at both ends, encircled with a spiral groove in which is wound a transparent flexible celluloid tube, the bottom end of which is cemented in and communicates with the interior of the brass chamber.

An extension of its lower head passes through the bracket, which supports the gage, yet allows it to be revolved at will, around its vertical axis. A small hose cock, to which a rubber tube can be attached, admits pressure through the top head of cylinder. Distilled water, usually colored, is put in the cylinder through this cock until the zero mark is reached on the scale.

Pressure will cause the level of the liquid to ascend in the tube and for every inch of vertical rise, it will travel around the cylinder, a distance of about 9 inches, which is divided into 100 equal parts. The angle of the tube is such that the plane of the minisci is radial, making close reading possible. The cylinder can be rotated so that the level of the liquid comes on the front side.

Rarefaction causes the liquid to descend, and by adjusting the cock, any degree of steadiness of the level in the tube may be obtained. The upper end of the tube is closed with a screwed brass plug and the inlet cock is shut when the gage is carried about, maintaining the liquid in place without danger of spilling.

As the tube is tough and elastic, it is not liable to be broken. The whole device is 3 inches diameter by about 12 inches long, and weighs about 3 pounds.

* * *

A large industrial plant for the manufacture of "fiberloid" has recently been put up at Indian Orchard, Mass., consisting of 20 brick buildings. Fiberloid is practically the same as celluloid, but it is made from a different base, by a somewhat different process. The base of celluloid is tissue paper, while fiberloid is made from fine cotton yarn or rovings. Collars, cuffs, combs, brushes and mirror backs are some of the products manufactured at this plant; also large sheets of fiberloid of various colors, from which are made various articles such as imitation tortoise shell combs. These goods were formerly manufactured by the dry process in which there was some danger from explosion, but in the new wet process they are said to be entirely safe. The plant is built in the latest design and most approved methods of modern mill construction, and covers a large area of ground. All the buildings are heated and ventilated by the Sturtevant fan system and not only is this system applied for heating and ventilating but also for special drying, cooling and exhausting arrangements. In the sheeter dry house there is a special Sturtevant drying apparatus for drying the sheets of fiberloid; in the sheeter room is a special cooling apparatus for maintaining an even cool temperature necessary in the process of manufacture, and a special ventilating equipment is installed in the rolling mill to keep the atmosphere pure and healthy. The equipment of this extensive plant illustrates some of the various uses to which the fan is now applied.

* * *

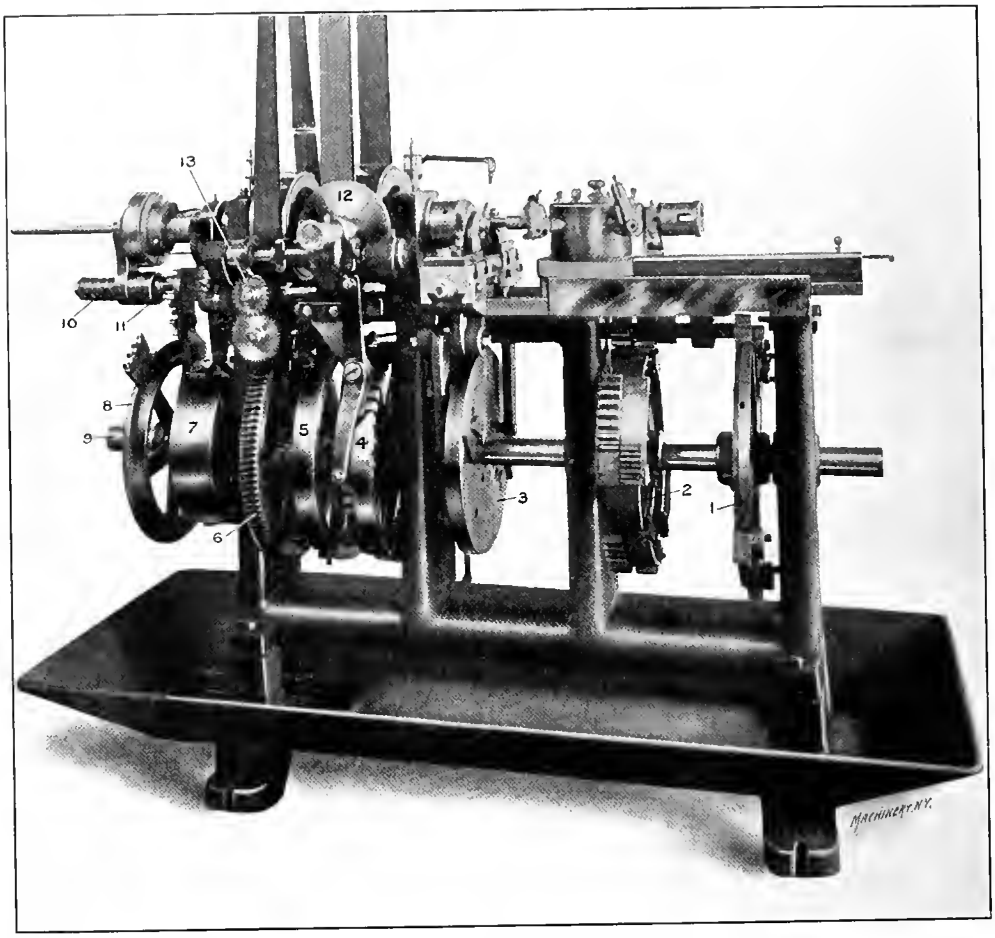
The staterooms of the steamships *Minnesota* and *Dakota*, now nearly completed at New London, Conn., for the Pacific trade, are to be heated with electric heaters, similar to the electric heaters used in trolley cars. These vessels are designed primarily for freight purposes, but provide unusually attractive accommodations for such passengers as are carried and the electrical equipment is said to be the most complete ever placed on shipboard.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

NEW AUTOMATIC SCREW MACHINE.

A new universal automatic screw machine, the invention of J. P. Lavigne, master mechanic of the Detroit Lubricator Co., Detroit, Mich., is shown in the accompanying illustration. The construction of the machine is such that any one can set it up for any piece of work, by means of the instructions furnished, as the adjustments are not at all complicated. It will produce any class of work without requiring any parts such as cam faces, which heretofore have frequently had to be designed for the work to be performed.



The Lavigne Automatic Screw Machine.

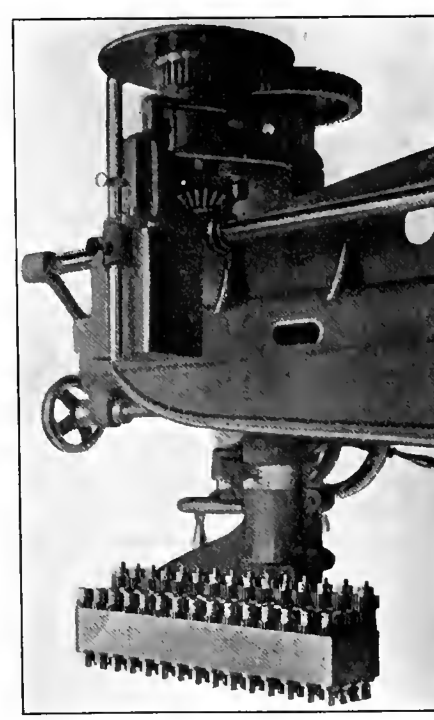
The machine is driven by two belts running on pulleys which are loose on the main spindle. One of these belts is simply for the reversal of the spindle, while the other one drives it in a forward direction while the tools are cutting and also furnishes power for rotating the cam shaft marked 9 in the engraving. Power is transmitted to the cam shaft through the friction disk 12 which runs in contact with a leather surface on the forward belt pulley. This friction disk is carried by a sleeve on a short horizontal shaft which it drives by means of a worm and worm wheel, and thence transmits power to the cam shaft 9 by the train of gears 13, which finally give motion to the wormwheel 6. Inasmuch as the timing of the different parts of the machine is governed entirely by the speed of this cam shaft, it is desirable to have means for adapting this speed to the different requirements. This is accomplished by two speed devices. One of these consists of a set of differential back gears attached to the shaft which drives the wormwheel 6, and the other, of arrangements for moving the friction disk 12 longitudinally on its shaft, which gives a smaller but gradual variation in the driving speed. The friction disk is moved by a lever which derives its motion from cams attached to wheel 4, and which can be so adjusted by means of slots in the face of the wheel as to give any desired motion to the disk at any time during the revolution of the shaft.

The differential back gears are operated by a clutch. This clutch is thrown in or out by cams clamped to one side of the wheel 5. The clamps are also attached to the other side of this wheel for operating the clutch connecting one or the other of the two main belt pulleys with the lathe spindle. The type of cam used on wheel 5 is used throughout the machine wherever possible, since it is easily attached and can easily be adjusted to any position. The chuck for holding the stock is operated by cams on the wheel 7, and the device for feeding the bar of stock through the spindle is operated by toothed segments on the wheel 8. At 10 is a coarse pitch screw, the rotation of which moves the stock-feeding device. On the right-hand end of this screw is pinion 11 and below it is an intermediate pinion. These are so located that one of the segments clamped to wheel 8 will mesh directly with the pinion attached to screw 10, and the other segment will mesh with the intermediate pinion turning the screw in the opposite direction and thus moving the feed device back to position where it is ready for again feeding the stock forward.

Now going to the other end of the cam shaft we find wheel 1 for moving the turret-locking bolt in or out of position by means of cams clamped to the periphery of the wheel. At 2 is a wheel carrying two sets of segments designed to mesh with pinions which rotate a screw visible under the turret, causing a nut on the screw to travel back and forth and thus operate the turret-turning mechanism. The distance that the turret is turned at any time is governed by the length of the segment on wheel 2. At 3 are two disks clamped together, which carry cams for operating the tool slides. These disks can be adjusted relatively to one another by twisting slightly upon the shaft, so as to bring the two tools into position where they will operate on the stock simultaneously.

MULTIPLE DRILLING ATTACHMENT.

The Mueller Machine Tool Co., Cincinnati, O., have brought out a new drilling device



Multiple Drilling Attachment for Radial Drills.

which we show herewith, to be applied to a radial drill. This device permits 60 holes to be drilled at the same time by operating the usual feeding levers.

The main casting, or head, is clamped to the machine sleeve, which is raised and lowered by means of its rack and pinion. The radial spindle runs loose in this head, and, by means of teeth cut on the spindle next to the sleeve, drives the sixth gear in the first row of 15 spindles, which mesh together. These spindles have 1½ inch centers, and each of them drives three others in rows at right angles to the first row. Their centers are 1⅛ inches in order to allow the teeth of their gears to pass each other as they run in opposite directions. Thus 30 right- and 30 left-hand drills are used to do the drilling. With the aid of a graduated dial on the cross screw, and a table having its adjustment at right angles to the radial arm, thousands of holes can be drilled with accuracy, down to ¼ inch center distances.

SHAPER INDEX CENTERS.

The three photographs herewith, illustrating index centers for shapers, tell their own story and require but little description. They are manufactured by the Stockbridge Machine Co.

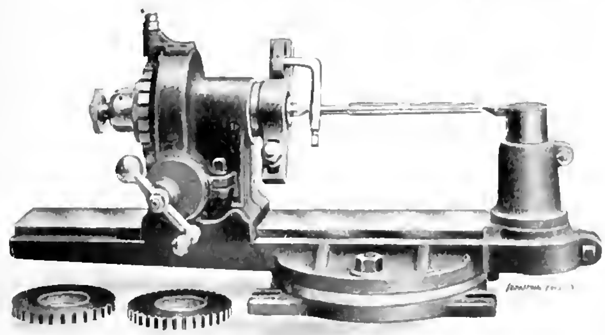


Fig. 1. Holding a Taper Reamer.

Worcester, Mass., the manufacturers of the Stockbridge shaper, and possess several points of novelty and usefulness that are original with this design.

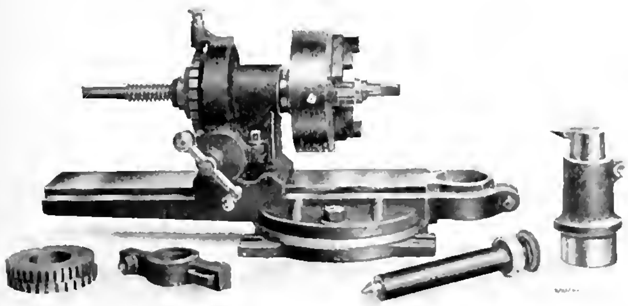


Fig. 2. Holding a Rod which Passes through the Spindle.

The illustration, Fig. 1, shows a taper reamer in position between the centers, and it will be noted that the tail center is raised sufficiently to bring the upper edge of the reamer parallel with the plane in which the shaper tool travels. Fig.

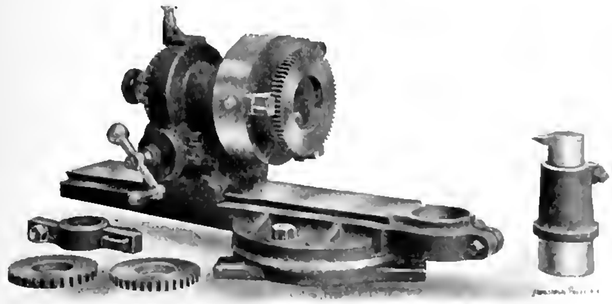


Fig 3.

2 shows the tailstock removed and the chuck attached in place of the dog holder. The spindle is also removed and a rod run through and held in the chuck, for squaring off the end. Fig. 3 shows a gear held in the chuck for the purpose of having the ratchet teeth cut.

The index centers swing 10 inches and take between centers 14½ inches. The hole in the spindle is 1 3-16 inches in diameter. It will be seen that the centers are designed to be used with a graduated base, such as is supplied with the Stockbridge shaper, but they can, of course, be used without this base by simply bolting directly to the shaper table.

NEW BENCH-STRAIGHTENING PRESS.

A bench-straightening press has been brought out by the Springfield Machine Tool Co., Springfield, O., which is of larger size than this company have heretofore made. The screw used in straightening the work is provided both with a hand wheel and a hand lever, the former being used for small work and the latter where considerable power is necessary. The hand wheel also permits adjusting the screw from large to small work, and *vice versa*, with rapidity. The centering heads are fitted upon a cold-rolled shaft 1½ inches in diameter, and have a capacity of 6½ inches diameter, with 40 inches between centers. Any length of shaft, however, may be straightened with this press, if occasion requires.

NEW UNIVERSAL JOINT.

The Boston Gear Works, Boston, Mass., have recently applied for a patent on an improved solid-ball universal joint coupling which they are now offering as a joint of unusually good design from the fact that it is strong and has no projecting parts. It is perfectly safe for the operator of the machine to stand close to one of these joints when running, as there is no possibility of his clothing catching.

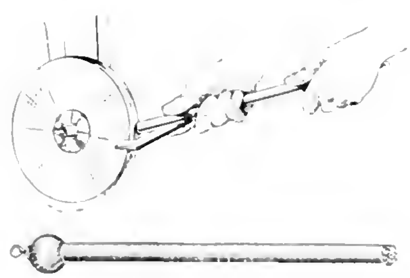
The bearing surface of the rubbing parts is also unusually large, so that it should be a durable joint. The only space inside the joint which is open is used for holding a lubricant,

A Ball Universal Joint.

which thoroughly lubricates the inside bearings. The opening of the oil well is closed by a screw. It is to be noted that this joint has a spherical bearing of large area directly on the ball, which latter is hardened and ground to exact dimensions. The joints are made with hub diameters of ½ inch to 4 inches and are manufactured in two styles: One for extra heavy duty and for angles up to 15 degrees measured from a straight line; the other style is not so strong but works up to angles of 30 degrees.

THE "SEMI-DIMOND" TOOL.

An emery wheel dresser manufactured by the International Specialty Co., 35 Holden Avenue, Detroit, Mich., is designed to take the place of the expensive black diamond. This is a most efficient tool for the purpose, and the makers write us that it will do the work of truing and shaping emery wheels



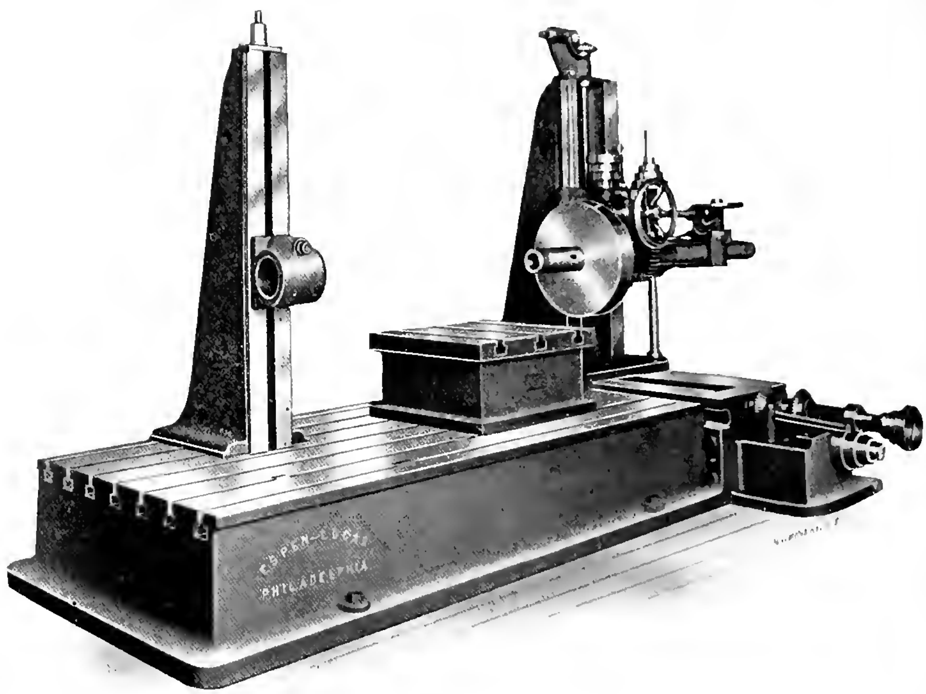
A New Emery Wheel Dresser

in as satisfactory a manner as the diamond dresser. The "Semi-Dimond" dresser is a steel tube filled with the hardest abrasive that can be obtained, which presents new cutting edges the entire length of the tube and as long as it lasts, which is from three to five years, with ordinary use. The

dresser is not recommended for water grinders or very hard wheels, although it can be used on such if necessary. Its efficiency is best demonstrated on grades up to medium hard.

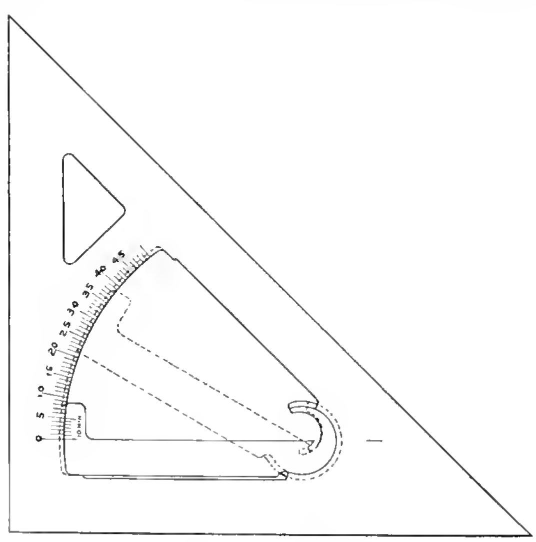
ESPEN-LUCAS HORIZONTAL FLOOR BORING, MILLING AND DRILLING MACHINE.

This new horizontal floor boring, milling and drilling machine has been designed by the Espen-Lucas Machine Works, of Philadelphia. This tool, while it conforms in its principal features to the more expensive and larger machines, is able to do the boring and a large amount of the milling heretofore necessarily done on the long milling machine. It covers an extra wide range and a great variety of work, being applicable to all kinds of boring, tapping, reaming and various kinds of milling, such as key-seating long, heavy shafting, etc. It can be used for face milling with a rotary cutter head like a rotary planer, and will do end milling and can be used for cotter drilling and cutting key-seats with an end mill. Large castings can be placed on the platen and work finished without removing the casting.



Horizontal Boring and Milling Machine.

The spindle, which is made of hammered crucible steel, is four inches in diameter and feeds through a gun metal sleeve. The boring bar has twenty inches of feed and has a No. 6 Morse taper hole in the end, also pin hole for retaining the bars and milling tools in place. The head has vertical adjustment of thirty inches and can be securely clamped in any position for milling. The column carrying the spindle head has automatic feed and quick return in both directions, giving forty-two inches of horizontal movement to the spindle head for milling. The spindle has feed in either direction for boring and counterboring both ends of cylinders. The machine, among other things, takes the place of the old style boring machine, where the work had to be adjusted to the spindle instead of the spindle being adjusted to the work, and, in this case, also relieves the milling machine of some of the large work, which would require a larger tool. The spindle is geared powerfully for heavy work and with ample power for drilling. It has a five-step cone which gives it eighty changes of feed and twenty changes of speed. The gearing is made of steel, cut from the solid and the bearings are all lined with bronze. The machine can be built with plain or compound table, or with both. The platen is forty-two inches by eighty-four inches, well ribbed to carry large and heavy work, the tail support being built with or without horizontal adjustment. Accurately adjusting screws and micrometer adjusting dials are also attached, if required. The countershaft is so arranged that spindle can be run in either direction. Length and width of table, also length of movements in all directions can be increased to suit requirements.



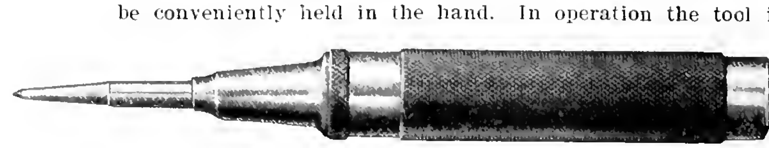
Celluloid Protractor Triangle.

A NEW PROTRACTOR TRIANGLE.

The accompanying illustration shows a draftsman's triangle, with a protractor combined, which is apparently an unusually useful tool, especially for rapid detailing. The tool is a 45-degree triangle, made in two sizes, 6 and 9 inches. It is of celluloid and the protractor arm is sprung into position, fitting snugly in V-grooves in the opening cut out of the triangle for the purpose. Just enough spring is given to the arm to maintain sufficient friction, so that it will stay in any position and yet can be moved readily. This arm has a vernier reading to 10 minutes, so that it can be set with sufficient accuracy for most requirements. When set at the 30-degree divisions the triangle becomes a convenient 30—60-degree triangle. One of the advantages of the construction is that lines which make a slight angle with the vertical and horizontal lines of the drawing, such as screw threads, for example, can be conveniently drawn by the use of a T-square and one of these triangles. It is made by the Triangle Protractor Co., Worcester, Mass.

BROWN & SHARPE AUTOMATIC CENTER PUNCH.

An automatic center punch has been brought out by the Brown & Sharpe Mfg. Co., Providence, R. I., which is entirely new in its design, combining features that make it much more convenient and accurate for laying out work to be machined or drilled than the ordinary center punch and hammer. The tool is self-contained, the striking mechanism being enclosed in the knurled handle, which is of such size and form as to be conveniently held in the hand. In operation the tool is similar to the automatic hammer used by dentists and with which readers of MACHINERY who have had occasion to resort to the dentist chair are probably familiar.



Brown & Sharpe Automatic Center Punch.

In operation the point of the punch is placed at the point where the prick punch mark is desired, the handle is pushed down, which compresses the spring, and at the proper point the spring is released and causes the striking mechanism to deliver the blow. The tool is about $5\frac{1}{4}$ inches long by $\frac{5}{8}$

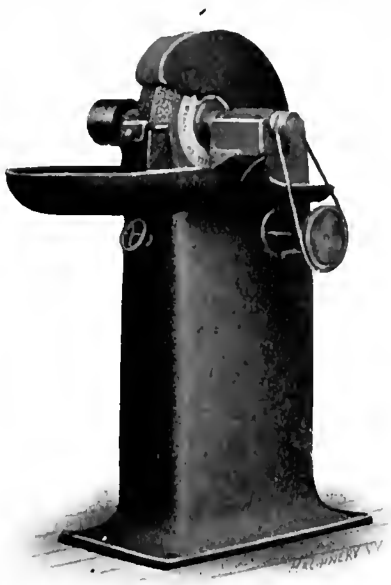
inch in diameter. In designing it every care has been taken to combine lightness and simplicity with durability. The various parts are proportioned to withstand the most severe usage to which a tool of this character should be subjected.

When following a line or establishing a point by the intersection of lines, one hand can be free to guide the point or hold the magnifying glass and, after the point is located, it is not apt to slip and lose the setting, as just a downward pressure of the handle releases the striking block and makes the impression.

Another advantage appreciated by mechanics is that the punch marks are all of uniform depth and, therefore, more easily and accurately followed than when of varying depths.

AUBURN TOOL GRINDER.

A new tool grinder, shown herewith, is manufactured by E. F. Allen & Co., successors to George J. Ridley, Auburn, N. Y., manufacturers of the Auburn tool grinders. In this machine the water tank is located inside of base and below the touch of the grinding wheel. A disk located in a separate apartment revolves with sufficient speed to throw water up and onto the wheel. Water is admitted to the disk chamber by means of a special valve which is regulated by a hand-wheel in front of the machine. The rest is solid and substantial and



Auburn Tool Grinder.

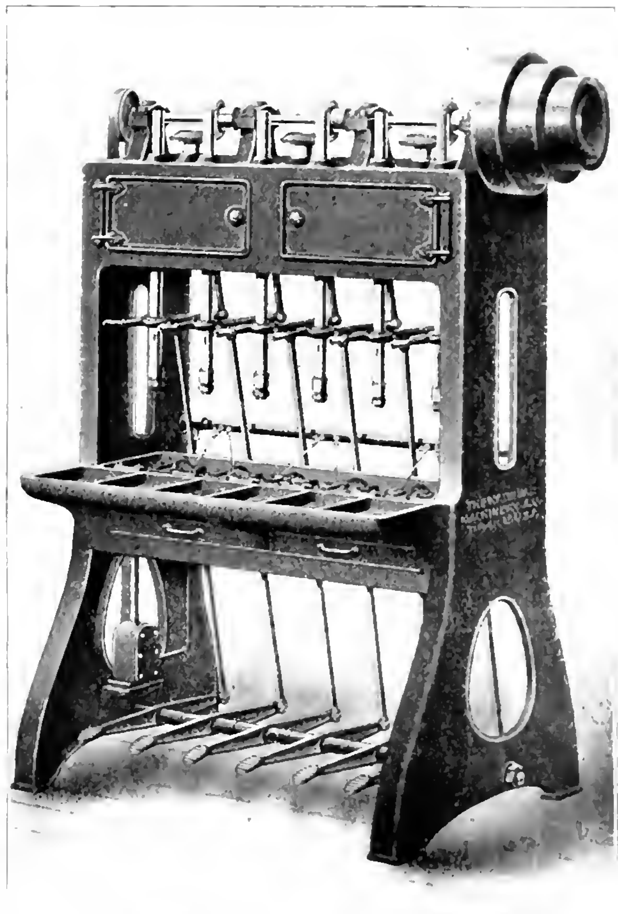
is high above any obstructions so that the tool may be held in any desired position. The wheel is covered with a hood provided with an adjustable water guard. It will be seen from this description that the machine possesses several advantages in being free from levers, treadles, pump, pipes or other devices liable to get out of order or to be adjusted or operated each time the machine is used. It is automatic in action. When the machine is at rest the grinding wheel cannot be left soaking in the water, which is a very desirable feature.

THE "NATIONAL" NUT TAPPER.

The accompanying illustration shows a nut tapper recently placed on the market by the National Machinery Co., Tiffin, O. This machine is compact, simple and easily operated, and is intended for tapping small nuts in large quantities. Special attention has been given to the convenience of the operator, so that he may take full advantage of the high tapping speeds to which it is designed to run.

Each tap spindle is equipped with both a foot treadle and a hand lever, the latter to be used in starting the tap, should the operator allow it to become dull. Tap sockets are so designed that taps can be removed or inserted while the machine is running at full speed, but any spindle may be stopped independently of the others merely by lifting its hand lever to the highest point. Nuts with either right or left-hand threads can be tapped with equal facility.

All gears are cut from solid stock, and are inclosed in a housing which protects the gears from dirt and the attendant from being caught in the gears. The rotary pump, shown near the bottom of the machine forces oil in jets against each tap, lubricating it, cooling it, and washing away the chips. The oil and chips drain into two iron drawers with screen bottoms. The screen retains the chips, but the oil filters through and returns to the pump.

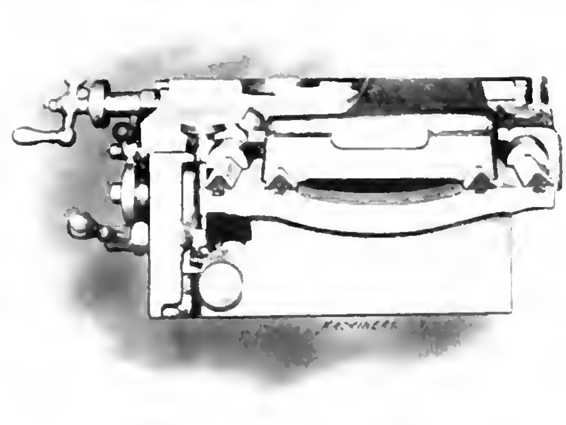


National Machinery Company's Nut Tapper.

All joints are machined, making each part rigid and true. All bearings are scraped, and adjustments for taking up wear are provided at all necessary points. All parts are machined to standard size, and repairs are interchangeable. The regular equipment includes six taps and tap sockets of any size within the capacity of the machine.

OSGOOD LATHE WAYS.

Some two years ago we called attention to a patent which had been issued upon steel lathe and planer ways which were to be inserted in the bed of the lathe, or table of the planer, in place of the usual cast-iron ways which are part of the casting itself. The use of these ways has now been developed so



Osgood Hardened Steel Lathe Ways

that they have been placed on the market by J. L. Osgood, 121-131 Erie County Bank Building, Buffalo N. Y. The application of these ways to a lathe is shown in the accompanying illustration. They are of cold-drawn, very high-carbon

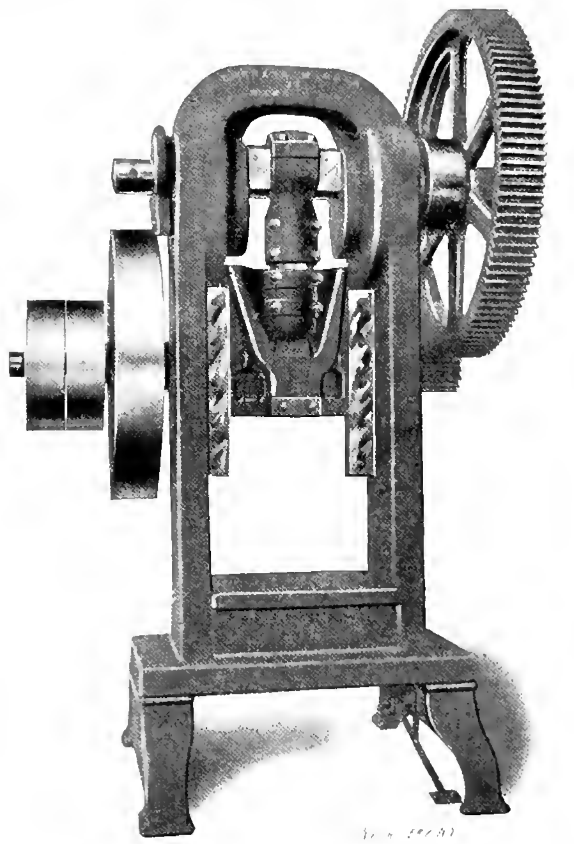
steel, and are smooth, true and bright, can be furnished in any lengths, with dimensions within limits of 0.002 inch.

In the circular supplying information upon these guides it states that they will not dent, grind or cut, and have a hardened surface which reduces friction and prevents wear. They will stand heavy strain and high-speed tool steel without showing signs of wear.

These guides are either sold separately or lathes will be supplied fitted with them, as desired. They are also well adapted for the repair of old lathes having guides which are defective. They are made in 9 sizes, ranging from 13-16 inch wide for 10 and 11-inch lathes up to 2½ inches wide for 48-inch lathes. The sides of the guides make angles of 45 degrees with the horizontal.

HEAVY STAMPING AND FORMING PRESS.

The illustration herewith shows a new press that has been brought out by the Perkins Machine Co., Warren, Mass., with improvements especially adapting it for heavy stamping and forming. The press has an 8-inch stroke of plunger, the plunger ways being set off center, so that the center of the plunger overhangs a distance of from 4 to 5 inches. By this



New Perkins Press.

construction the press can be so adjusted that the ram will travel up above the lower ends of the guides and the guides will not interfere with the punch, which has heavy strippers and spring bolts. The adjustment of the plunger can be effected quickly by a slight turn of the screw, which latter has a right- and left-hand thread.

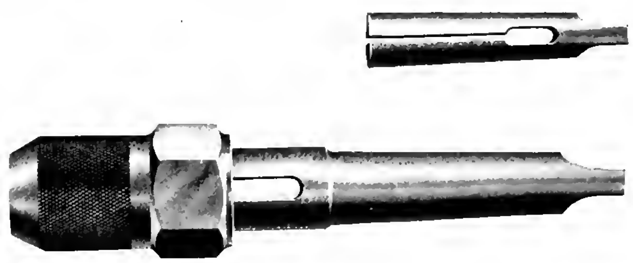
DRILL CHUCK FOR TAPER SHANK DRILLS.

The National Twist Drill and Tool Co., 21st and Standish Streets, Detroit, Mich., have placed a drill chuck on the market designed especially for holding taper shank drills. It will hold any such drills securely, even after the tang has been broken off.

The body of the chuck is bored out to form a taper socket, and is split so that it can be compressed slightly by a taper sleeve, which screws on the outside of the chuck. For smaller size drills split taper collets are used and for drills having the Graham grooved shank a special collet is provided, not shown in the engraving.

It will be evident that the construction is such as to enable the chuck to bear firmly against the whole taper surface of the drill shank, making practically one solid body of the drill, the collet and the chuck.

The chuck is made in several sizes, to accommodate a wide



National Twist Drill Holder.

range of drill sizes. The parts of the chuck are interchangeable, and new collets can be ordered at any time. The chuck is made of tool steel, properly hardened.

* * *

FRESH FROM THE PRESS.

BOILER CONSTRUCTION, by Frank B. Kleinhans. 421 pages, 5½x7¾ inches, illustrated with 334 line cuts and half-tones, and five large plates. Published by the Derry-Collard Co., 256 Broadway, New York. Price, $3.00.

This work is essentially one for the working boilermaker, being "a practical explanation of the best modern methods of boiler construction from the laying out of sheets to the completed boiler." It is confined to the problems of construction involved in the locomotive type, the inference being that any boilermaker who is competent to handle the difficult construction required in modern American locomotive boilers, should be amply competent to cope with the simpler construction of stationary and marine types. The work logically begins, of course, with the laying out of the sheets, taking up in order gusset sheet development, development of irregular shaped sheet, laying out of dome sheet, dome base, first course, laying out first course sheet, front tube sheet, smokebox sheet, etc. Following the section or chapter on laying out which covers nearly 60 pages, are sections on flanging, forging, punching, shearing, bending, machining parts, under which general head comes drilling, turning and boring, tapping and reaming, planing, milling, etc. The important subject of riveting is comprehensively treated, following which are boiler details including under this head stay bolts, crown stays, crown bar bolts, crown bars, etc. A specially valuable feature of the book is the numerous half-tone illustrations of modern boiler shop tools, but the practical boilermaker will doubtless more appreciate the fine line cuts from actual working drawings with which the different sections are copiously illustrated. The work is what we believe to be one of the most practical and comprehensive mechanical books ever published. No expense has been spared to make the illustrations the best obtainable. Mr. Kleinhans, the author of the work, is well known to our readers as a clear and logical writer on problems in theoretical and constructive mechanics. He has had a wide practical experience, including service with the Baldwin Locomotive Works where the larger part of the data for this work was collected. The book is handsomely bound in drab cloth with a symbol on the front cover representing the tubesheet of a boiler. For some reason the imprint of the title was omitted from the back which we believe was a mistake when the convenience of being able to select a book from a row on a library shelf by inspecting the titles on the back, is considered. This, however, in no way detracts from the general excellence of the work —would that there were more like it.

MANUFACTURERS' NOTES.

MR. GEORGE K. WILLAND, formerly secretary of the Washburn shops, Worcester Polytechnic Institute, recently tendered his resignation, to take effect August 1. Mr. Willand has been connected with the Institute for the past 10 years, but is now to enter in the manufacturing business in Worcester.

THE STANDARD ENGINEERING CO., Elwood City, Pa., makers of bolt threaders and pipe threading and cutting machines have appointed Mr. A. Schaefer their New York sales manager, with office at 150 Nassau Street.

THE CINCINNATI MACHINE TOOL CO., Cincinnati, O., have now completely moved their plant and are located in their new quarters at Spring Grove Avenue and Townsend Street, which plant is particularly designed for the building of upright drills. They state they will be glad to show interested parties through at any time.

THE FOOTE BROS. GEAR & MACHINE CO., at Chicago, Ill., have succeeded the firm of James & Foote, whose good will and plant they have recently purchased, excepting bills receivable and bills payable. They will continue the old business at their permanent location 24-30 So. Clinton St., Chicago, Ill.

THE INGERSOLL-SERGEANT DRILL CO., New York, have received an order from the O'Rourke Engineering & Construction Co., who have the contract for building the Pennsylvania tunnel under the Hudson, for two Central compressed air power plants to be located at New York City and at Weehawken, N. J. This order includes eight 36-inch stroke Corliss air compressors each of 3,890 cubic feet capacity.

HENRY R. WORTHINGTON CO. are distributing a small map showing the location of their old works in South Brooklyn, their offices in New York and their new works at Harrison, N. J. The new plant occupies a 34-acre tract, has 18 acres of floor space and will accommodate 6,000 workmen. It is said to be the largest industrial plant near New York, and embraces the latest improvements in engineering production.

THE PERKINS MACHINE CO., Warren, Mass., who recently moved from South Boston to a larger factory at their present location, Warren, report that owing to the large orders which they are receiving they are still running day and night to execute same. They have been obliged to add another crane to their equipment, the addition being a large Pawling & Harnishfeger three-motor electric traveling crane, of the latest model.

NEW TRADE LITERATURE.

Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes

THE ECK DYNAMO & MOTOR WORKS, Belleville, N. J. Bulletins No. 34 and 35 of the "Eck" small motors for direct current, with price list.

MACHINERY.

October, 1904.

THE DE LAVAL STEAM TURBINE COMPANY.

THEIR WORKS AND PRODUCT, WITH SKETCH OF DE LAVAL, THE INVENTOR.

Carl Gustaf P. De Laval, the Swedish Inventor.

The works of the De Laval Steam Turbine Co., Trenton, N. J., were built in 1901 and occupy a unique position among the machine shops of the country in that they were the first shops in America to be devoted exclusively to the manufacture of steam turbines. The buildings embody the most modern ideas, and in design follow out certain desirable features of construction of the parent shops at Stockholm, Sweden, where the original De Laval Company is located. Besides the American and Swedish companies there are also the French De Laval Company (Societe de Laval), located at Paris, and the English company (Greenwood & Batley), at Leeds, England, so that the American works are one of a system of factories engaged in the manufacture of steam turbines and turbine machinery, under the De Laval patents, in different parts of the world.

Since the works were first put into operation at Trenton, the methods of manufacture have been systematized until the point has been reached where the quality of product, both in the matter of finish and accuracy of the individual piece and in the interchangeability of parts, is to be classed with the best work of our leading machine tool shops. This fact alone places the De Laval Company in a unique position among concerns manufacturing steam machinery, for up to the advent of the steam turbine it has not been thought necessary, or even possible, to manufacture parts of steam engines or other prime movers of corresponding sizes on the strictly interchangeable plan. In a subsequent article something will be told about the interesting methods of manufacture carried on at this plant, and the special machinery in use.

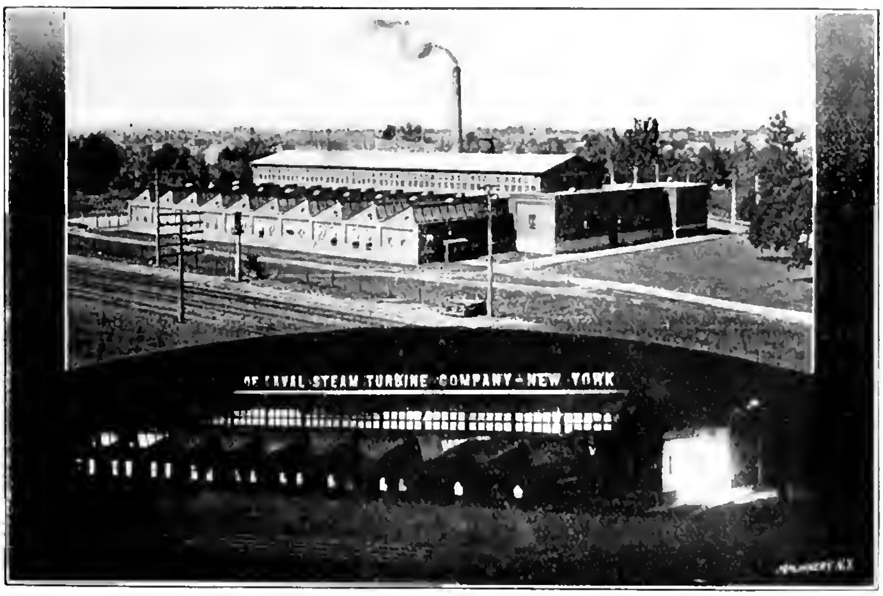


Fig 1. The Plant of the De Laval Steam Turbine Company, Trenton, N J., by day and by night. The main building is nearly a square structure, 200 by 210 feet, with a high crane shop running through the center and sections on either side lighted by saw-tooth roof At night the roof sign is lighted by reflected incandescent light generated by a turbine unit. This turbine is started after the plant is shut down at night and runs for four hours on the steam pressure remaining in the boilers, without additional firing. Steam is thus utilized which would ordinarily be lost at night by radiation.

The De Laval steam turbine must run at such extremely high speeds and, in order to compete with the steam engine, must be so reliable for constant service day in and day out, that it is absolutely necessary to have materials and workmanship as nearly faultless as possible. In fact, it is probably because of the possibility of securing uniformly high-grade materials and superior machine work that the turbine has proven its reliability under constant and severe service; for without these it would not be feasible to run a turbine wheel at 30,000 revolutions or more a minute, nor gears at a peripheral speed of eight or ten thousand feet a minute. The foreign De Laval companies have in operation about 3,000 on land and about 500 on shipboard, making more of this type than of all other foreign turbines combined; although it has not been considered advisable to construct the De Laval turbine in sizes larger than 200 K. W. capacity, so that the total horse power of these machines would be smaller in proportion than of the others. The first turbine built by the American company was in the fall of 1901, since which time over 400 have been completed, aggregating about 39,000 horse power.

Dr. Gustaf De Laval.

The original De Laval steam turbine is the invention of Dr. Gustaf De Laval, the famous Swedish scientist whose portrait appears on this page. Dr. De Laval was born at Blasenborg, Sweden, in 1845. He was educated at the University of Upsala, Sweden, and the technical University of Stockholm, where he graduated with highest honors in 1866. He was then employed with the Stora Kopparberg Mining Co., but believing his training not sufficient he decided to take a special course of several years' duration in physics and mathematics, at the University of Upsala, where he received the degree of Doctor of Philosophy. He again entered the service of the mining company and became interested in the erection of a plant for the manufacture of sulphur. Later he entered the service of the Kloster Iron Works, Germany, as mechanical engineer, and shortly afterward made his first two inventions—one relative to a new strainer, which was to effect a more perfect separation of air in Bessemer converters, and the other a crucible for galvanizing purposes. He experimented on centrifugal machinery and this led to his first ideas in connection with the centrifugal cream separators, which he believed would become of enormous importance to the agricultural and dairy industry if developed and perfected. His judgment in this has proven to be correct. The results of his efforts, in the dairy industry throughout the world, easily place him among the great inventors who have reduced the labors of mankind by their work. As the Kloster Iron Co. did not appreciate the importance of this invention he resigned and returned to Stockholm with the determination to thoroughly develop his cream separator ideas. These ideas were so radical that they met with considerable opposition, but he finally produced a commercially successful machine, and although it has since been modified the general principles have remained the same. Over 600,000 De Laval cream sep-

arators are in service to-day throughout the world; the American Separator Company making the cream separators has an extensive plant at Poughkeepsie, N. Y.

Dr. De Laval also perfected other useful inventions in connection with dairy apparatus, one of which was the "lactometer," by which the percentage of butter fat in milk could be determined in a simple manner, and the use of which modified the method of paying for milk, by dairy companies. Formerly milk had been paid for either by the quantity of milk itself or by the quantity of cream, without regard to the quantity of butter which the milk was capable of producing. The field of activity of the inventor, however, was not confined solely to agricultural machinery, for Dr. De Laval established a factory for stamping out utensils in steel, which resulted in a large and profitable industry, and he also devoted considerable time to experiments with a new type of steamboat.

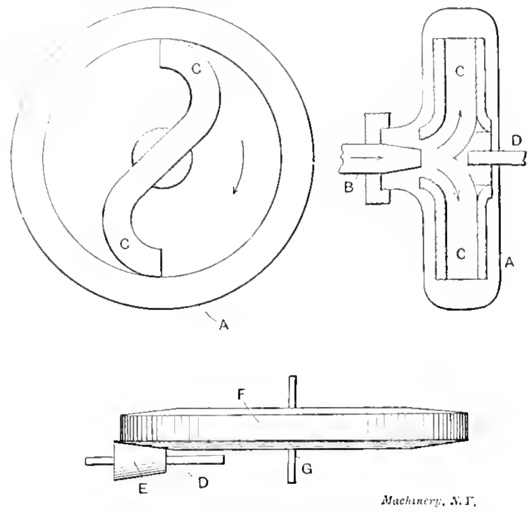


Fig. 2. The first De Laval Turbine.

In the manufacture of his separator he conceived the idea of a steam turbine as an ideal motor for driving the separator, which must itself run at extremely high speeds, and from this has grown the De Laval steam turbine industry.

About 1882 Dr. De Laval invented his first steam turbine, which was on the principle of the Hero engine. This is illustrated diagrammatically in Fig. 2. Steam (or other fluid) entered the casing *A* by nozzle *B* and passed the curved hollow arms *C C*, formed like the buckets of an outward-flow hydraulic turbine, and the passage of steam along them caused them to rotate shaft *D*. This shaft drove another at a slower speed by friction wheels, the requisite pressure between friction surfaces being obtained by the axial thrust of the turbine wheel. The first commercially practical De Laval turbine was built in 1883 and used for driving a cream separator, to which it was direct-connected. It was of the reaction type, along the lines described above, but its efficiency was low on account of the imperfect expansion of the steam. Five years later, in 1888, he invented and used the diverging expansion nozzle in which the steam was completely expanded, and which mainly is responsible for the efficiency of the De Laval turbine. He had experimented with a steam nozzle for sand blast purposes as far back as 1870 but did not hit upon the idea of the diverging nozzle until the later date. The complete expansion of the steam in the diverging nozzle necessitated considerably higher wheel velocities than he had used before, and in order to overcome the great difficulty in balancing a wheel accurately enough to revolve around its center of gravity at a peripheral velocity sometimes as high as 1,850 feet per second, without causing destructive side pressure upon the bearings, he adopted the flexible shaft which, with the diverging nozzle, is employed in the De Laval turbine of to-day. These characteristic features, as shown in Fig. 3, have become so identified with the De Laval turbine that a representation of them is used as a trade mark by the company.

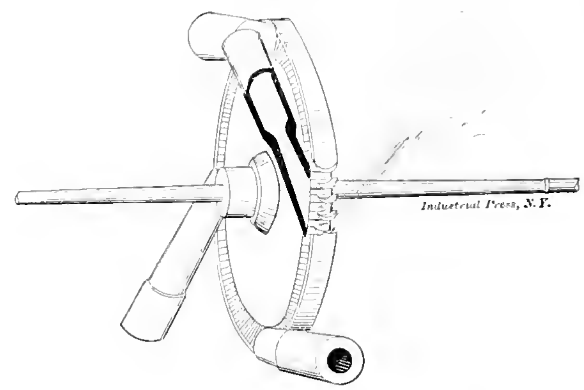


Fig. 3. The Main Elements of the present Turbine.

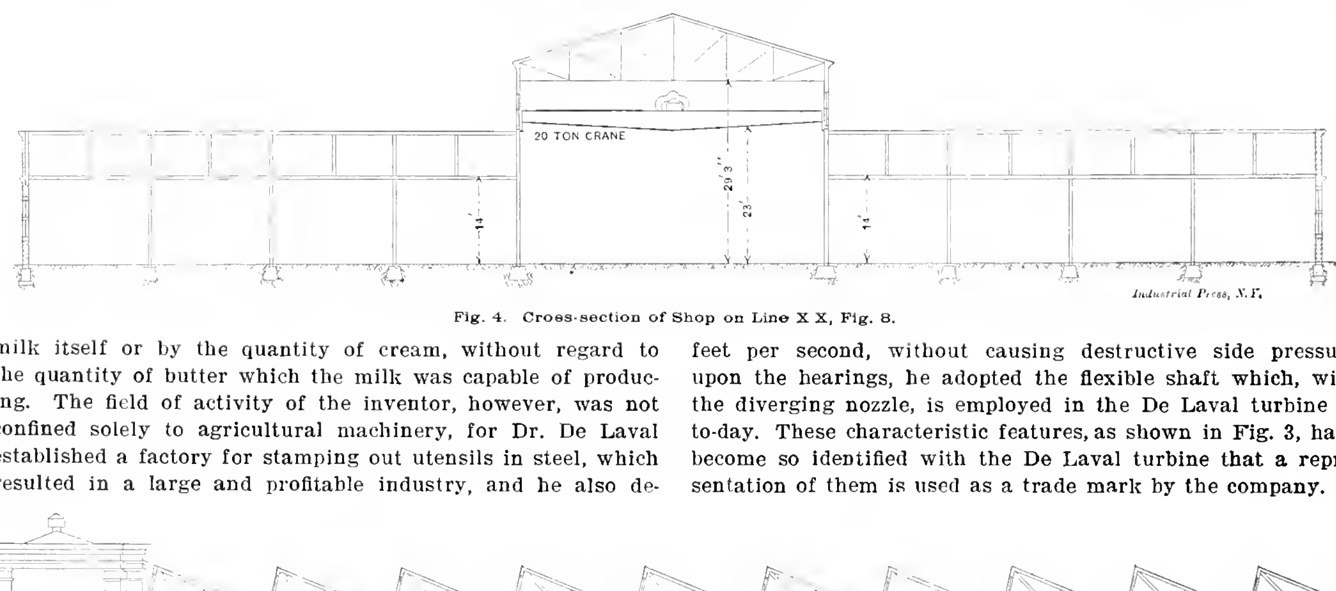


Fig. 4. Cross-section of Shop on Line X X, Fig. 8.

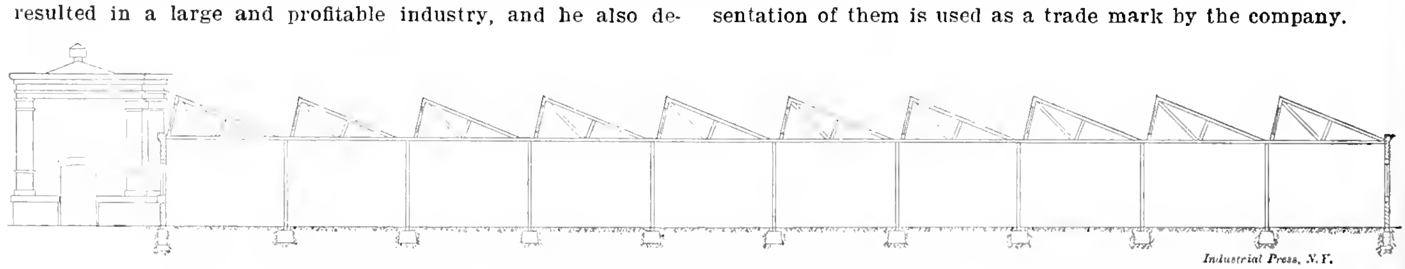


Fig. 5. Cross-section on Line Y Y, Fig. 8.

Dr. De Laval has had many distinguished honors bestowed on him by scientific and other societies and he has also served his government in various public capacities.

The De Laval Shops.

The shops at Trenton are located just outside the city limits, directly on the New York division of the Pennsylvania

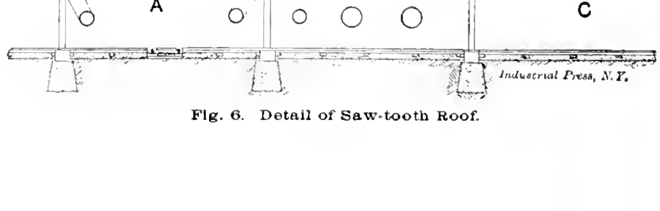


Fig. 6. Detail of Saw-tooth Roof.

Fig. 7. Side Elevation of the De Laval Works. Engine and Boiler House at the Right.

Railroad. The plot of ground contains about 10 acres and is large enough to allow an extension of about 900 feet in the length of the building, which is now 200 feet long. As stated, the buildings are of the saw-tooth type with a center crane shop 51 feet wide. The plan of the works is shown in Fig. 8 and cross-sections of the shops in Figs. 4, 5 and 6. Fig. 4 is a section taken on the line *X X*, in which the crane shop appears at the center; and the saw-tooth roof sections are shown in longitudinal section at either side. Fig. 5 is a section on the line *Y Y*, and in Fig. 6 is a detail of the saw-tooth roof construction, in which is indicated the location of one of the traveling hand cranes by which work is brought to the machine tools. The positions of the shafting are also indicated. The shop is served by two sidings from the railroad and also by its own individual shop tracks for transferring castings and completed machines from one part of the works to another. At present the offices and drawing rooms are located at *A*, Fig. 8, in one corner of the shop building, but an office building at the front of the shop is contemplated, as indicated in the plan.

The side view of the works, Fig. 7, shows the relative proportions of the main shop and the lower sections, as well as the location of the engine house, testing laboratory, etc.

Power is supplied by a steam turbine unit of 200 K. W. capacity built in Sweden, which has been in constant service almost without interruption since its installation, and the spiral gears and pinion and other parts, such as bearings, show no perceptible wear. The works are electrically driven, the smaller tools by the group system and the larger ones by individual motors. An interesting feature is the testing room, shown at *F* in Fig. 12. Here all turbine units are tested before shipping. The testing room is equipped with a large water rheostat, the water tanks being placed outside the building, after the usual custom, and there are also two

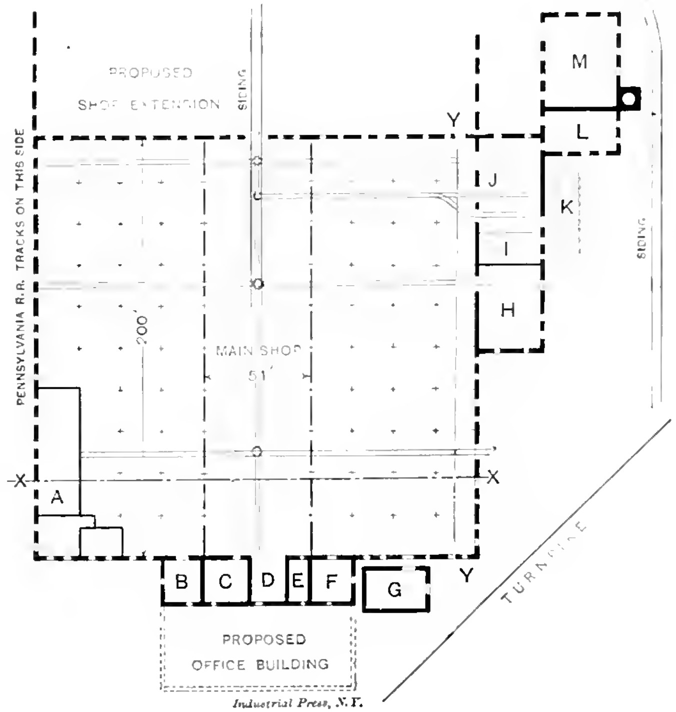


FIG. 8. PLAN OF WORKS.

A.—Offices and Drawing Room.
B.—Wash Room.
C.—Lavatory
D.—General Entrance.
E.—Timekeeper's Room.
F.—Wash Room.
G.—Pattern Safe
H.—Blacksmith Shop.
I.—Testing Office.
J.—Testing Room.
K.—Water Tank
L.—Engine Room
M.—Boiler Room

tanks beneath the floor of the testing room, to enable the centrifugal pumps, which form an important part of the products of the company, to be readily tested. The illustration *F*, Fig. 12, was taken while Prof. Denton, of Stevens Institute of Technology and Mr. Wm. Kent, consulting engineer, were conducting a trial of centrifugal pumps referred to later.

In the first illustration, showing the plant by day and by night, the illuminated sign is a conspicuous feature of the view, at night. This sign is painted a light cream color and is visible at night by reflected light by means of incandescent lamps. The lamps are placed in a reflector at the top of the letters, and three or four feet in front of same. It is interesting to note that the sign is lighted at practically no cost; that is, the boiler plant which has a capacity of 500 H. P. with a steam pressure of 200 pounds per square inch was found to be sufficiently large to operate a 30 H. P., 20 K. W. turbine dynamo running at about 70 pounds of steam pressure for four hours each night, practically without firing. One of these units was therefore installed, and the steam used for operating it after the close of the shops is merely that which was formerly wasted by morning through radiation, etc. All that is necessary is to place about 15 or 20 shovelfuls of coal on the grate at 10 o'clock at night. The lights are turned on at 7 o'clock and shut off at 11, after which the fires are banked the same as was formerly done after shutting down the shop. The machine is looked after by the regular watchman and therefore does not cost anything for attendance.

Electric Generating Sets.

The essential features of the DeLaval turbine are familiar to many of our readers; and, in any case, as it is proposed to enter into a detailed description of the construction in a subsequent article it will not be necessary to give more than passing notice to its features in the present article.

First to be noted in the turbine are the bucket wheel, flexible shaft, and the ring of nozzles, as mentioned above. The wheel rotates in a steel casing and the shaft is supported in bearings outside of the casing and also by a type of spherical stuffing box in the walls, to prevent the passage of steam or air around the shaft.

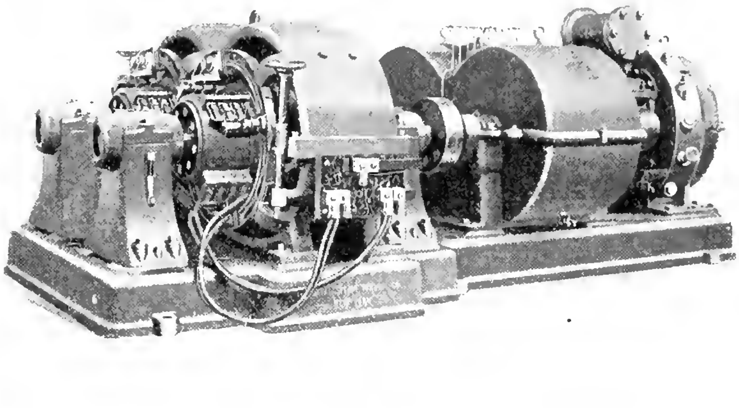


Fig. 9. Electric Generating Set, with Double Direct-current Bullock Generators.

On one end of the flexible shaft is a small spiral pinion which, in the smaller sizes, meshes with a single large spiral gear, and the larger sizes with two gears placed one on each side of the pinion. This latter arrangement balances the thrust of the gear transmission and also has other advantages for electrical generating and for driving compound pumps, as will shortly be explained. The turbine wheel rotates at speeds ranging from 10,000 to 30,000 revolutions per minute, and the smaller sizes have run up to 50,000 revolutions per minute, or more, under test. The gear shafts are reduced in speed so as to rotate at from 900 to 3,000 revolutions per minute, according to the size of the machine, which has been found satisfactory for dynamo driving and unusually well adapted for centrifugal pumps and blowers.

De Laval turbines find their widest application in connection with electrical generators. The turbines and generators are mounted as one unit on a single bedplate, and are all tested under full load before leaving the factory. At present the electric generating units are built in sizes of from 7 to 300 brake horse power, or 4-6/10 to 200 kilowatts. Up to 55 horse power, the De Laval turbine is built with the single large gear driven by the pinion on the turbine shaft; and in sizes above 55 horse power where the two-gear transmission is used, with two generators mounted side by side, as in the illustration Fig. 9. These larger sizes are especially

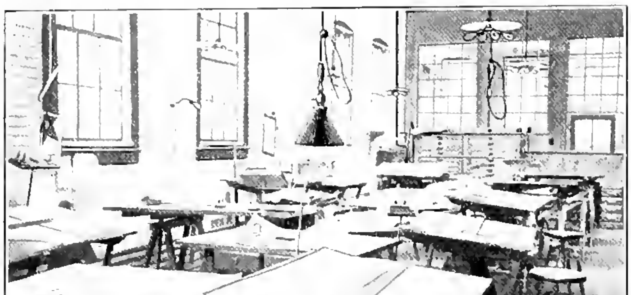


Fig. 11. Drawing Room.

adapted for factory purposes as they can be used either on a two- or three-wire system, running two voltages from the same unit, so that the motors distributed throughout the factory can be operated at one voltage and the lights at another. Thus, if 125-volt generators are supplied the lighting circuit would be connected in parallel, giving 125 volts for this purpose, and the motor circuit in series giving 250 volts. Owing to the short distance between the shaft centers it is possible to combine what would otherwise be two separate generator frames into one, at the same time leaving two openings in which the armatures revolve. The novelty of the arrangement is confined solely to its mechanical construction, and the dual generator is really nothing more than two generators separate in all their functions, but with their frames combined in a single casting.

When it comes to applying the turbine to alternating current generators provision must be made for rotors of larger diameter than the armature of the direct-current machines. Accordingly the generators, instead of being side by side are placed one in advance of the other. The size of the generator castings, therefore, is limited only by the condition that the frame of the machine nearest the turbine shall not come in contact with the driving shaft which passes by it to the generator furthest from the turbine. With this arrangement there is ample room for the alternating current machines when operated at the speeds of the geared shafts. The alternating current set makes a neat and compact unit, and the generators run at a high enough speed so that the exciter

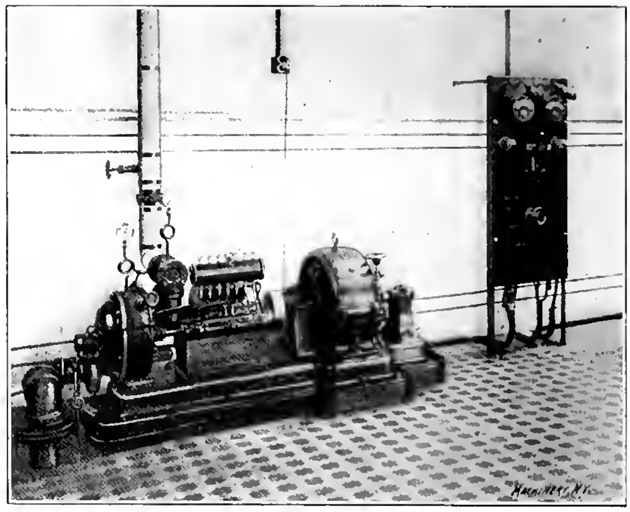


Fig 10. Thirty H. P. Generating Set in Power Plant for Lighting the Sign on Roof of Building (Fig. 1)

can be connected directly with the end of one of the gear shafts, thus dispensing with a belt connection.

Application to Centrifugal Pumps.

One of the successful uses of the De Laval turbine is in the operation of centrifugal pumps. This has not been considered as efficient as the plunger pump, mainly because of the low speed and imperfect design of such apparatus, and it has also been adapted only to low lifts. As the De Laval Steam Turbine Company were building high-speed turbines, however, which ran at speeds almost exactly the same as would be required to produce maximum efficiency in centrifugal pumps adapted to the different sizes of turbines, it was decided to design a series of pumps, of improved mechanical construction, which would admit of the high speeds necessary, and which would also enable the pumps to work against high heads. These pumps are supplied in connection with the turbines, or independently, to be driven by electric motor, when it is desired to locate the pump apart from the prime mover. The smaller units consist of a single pump, just as the small generator units have a single generator; but the larger units have two pumps driven by the double-gear turbine, one pump being connected to each gear shaft, permitting their operation in parallel for low pressure, and in series when high lifts are desired. Standard sets are built in sizes from 7 to 300 horse power for all heads up to 300 feet, handling from 90 to 26,000 gallons per minute. Lately a high-pressure centrifugal has been developed with the forcing pump having a runner of very small diameter

attached to the turbine shaft and rotating at the extremely high speed of that shaft. The centrifugal force developed by the runner under these conditions makes it possible to pump against heads of 600 to 1,000 feet, and to use the pump for boiler feeding. A runner operating at such high speed, however, would force out the water more rapidly than it could draw it in by suction, or under atmospheric pressure only, and hence the pressure pump is flooded with water at sufficient pressure to ensure an adequate supply, by a pump on the geared shaft.

The pump case, the lower half of which, together with the runner and shaft, is shown in Fig. 15, [illegible] through the center of the main bearing so that [illegible] is removed a thorough examination may be made [illegible] the working parts or any of the pipe connections. [illegible] centrifugal pumps the packing about the shaft serve[illegible] as a bearing and soon becomes worn, but in this machine the bearings are entirely independent of the shaft packing and are of the ring-oiling type. The lubricant thus cannot enter the pump chamber, which is important where a liquid would be damaged by the oil. Where hot water is to be handled flax packing is used, and where cold water is pumped

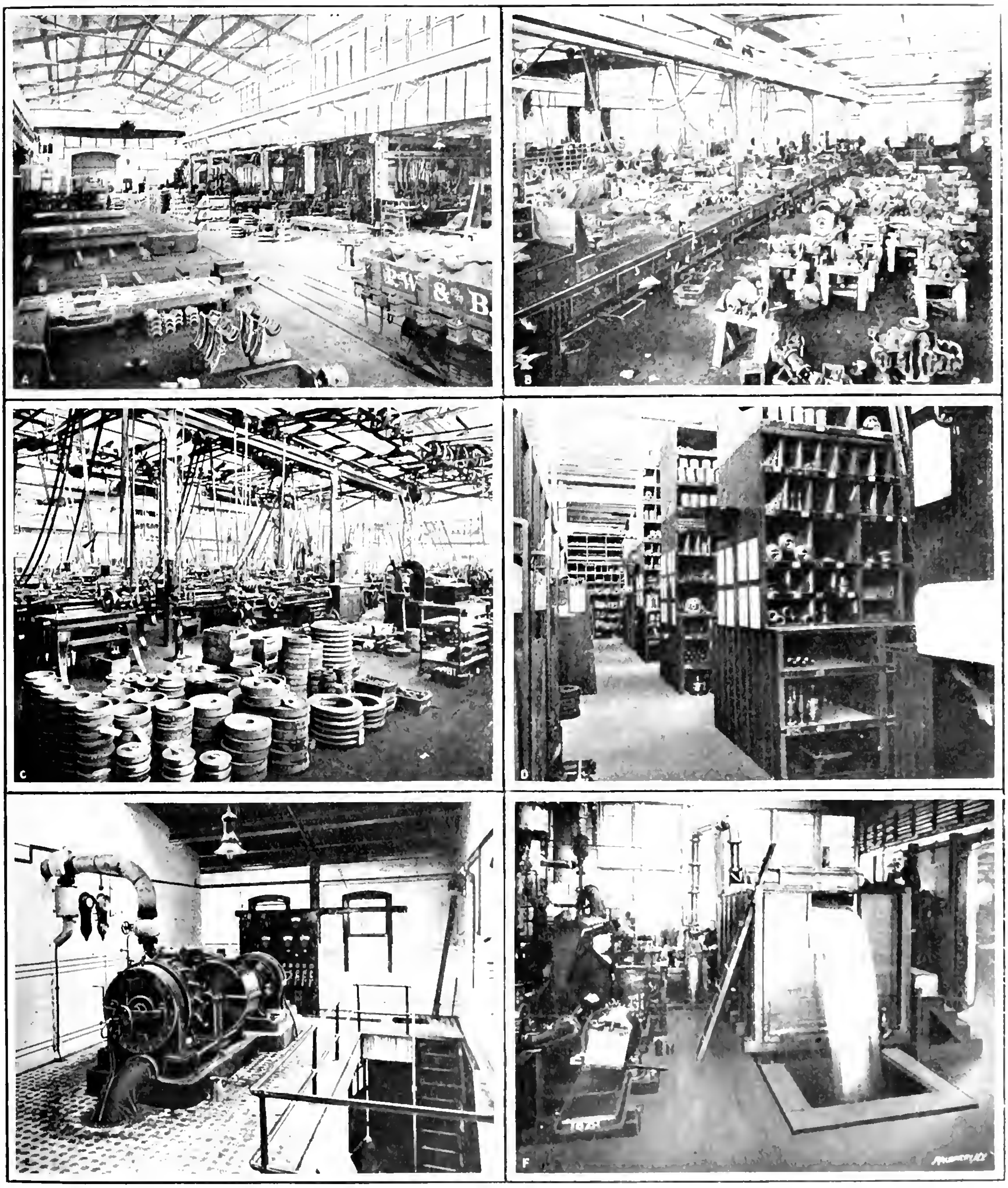


FIG. 12. INTERIOR VIEWS OF THE DE LAVAL WORKS

A. View of Crane Shop
B. Erecting Department for Small Turbines and Pumps, etc.
C. Lathe Department, showing the Excellent Lighting from the Sawtooth Roof.
D. The Large and Model Stock Room
E. Engine Room, with 200 K.W. Swedish Turbine.
F. Testing Room. Test of Centrifugal Pump under way by Messrs Denton & Kent

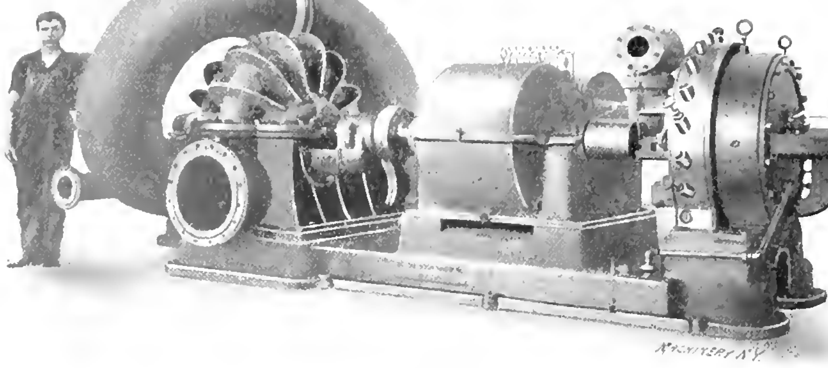


Fig. 13. Turbine Driving Two-stage Centrifugal Pump.

a cupped leather packing is employed, which is set out by the water pressure and prevents leakage of both water and air.

Water is drawn into the lower part of the pump casing and enters the runner at its center and is thrown outward through the runner in a radial direction by centrifugal force. The suction pipe connects with the portions of the casing

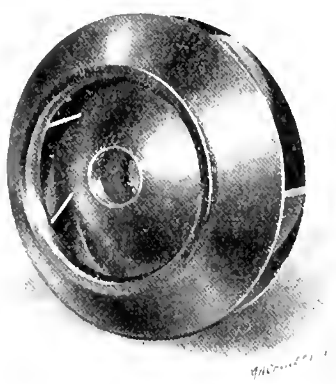


Fig. 14 Runner of Centrifugal Pump.

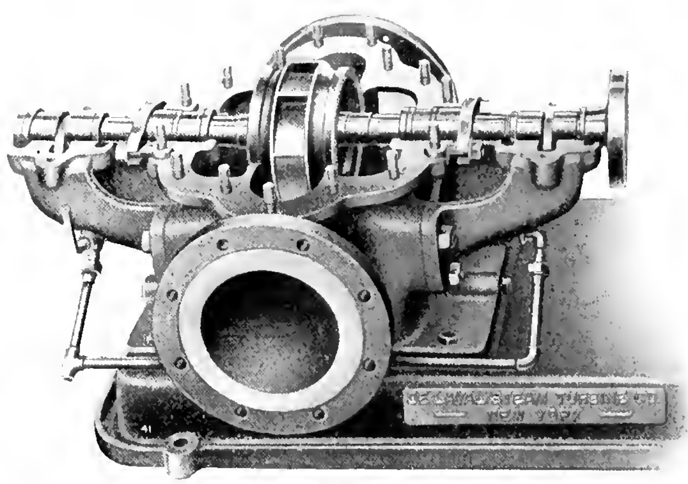


Fig. 15. Centrifugal Pump with top of Casing Removed

located at each side of the runner, Fig. 15, and the discharge pipe connects with the central portion in which the runner itself is located. The suction and discharge chambers are separated by vertical webs in the pump casing, bored to fit the cylindrical ends of the runner, as clearly indicated in Fig. 15. The liquid must therefore flow into and through the runner in order to pass from the suction into the discharge chambers. A channel cored in the casing runs from the high-pressure chamber to the packing glands and sets out the packings, as mentioned above. The outside of the packing is subjected only to the pressure of the suction chambers. The shaft is made of steel and provided with brass protecting sleeves at the packings and which also extend inward so as to prevent the steel shaft coming in contact with the liquid to be pumped. The runners are usually of bronze so that pumps may be used for corrosive liquids.

The development of centrifugal pumps at these works, and in connection with the De Laval turbine, it may be said, is only one instance where the centrifugal pump appears to be gaining ground over its older rival. Centrifugal pumps are used for general pumping conditions such as water works, irrigation, condenser circulation, boiler feeding, pumping pulp, sewage, heavy oils, etc. As constructed by the De Laval Company they give excellent satisfaction in handling liquids containing grit, because the only part to wear are the runners, the brass sleeves and the bearings; and as all the parts are interchangeable and easily accessible, any of them can be replaced on short notice. Such pumps have the advantage of absence of valves and water hammers, freedom from accidents due to breaks in pipe lines or losses in pressure, and the possibility of limiting the maximum obtainable pressure to any desired amount, by simply regulating the speed of

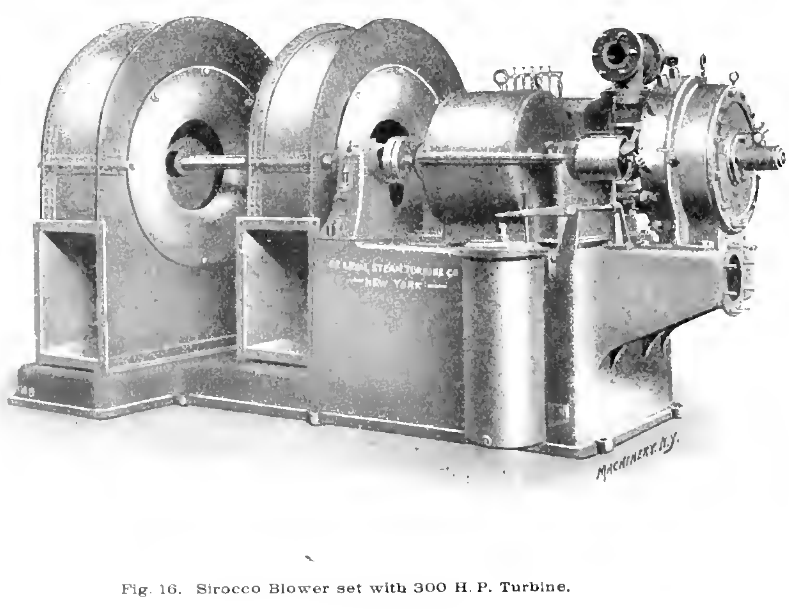


Fig. 16. Sirocco Blower set with 300 H. P. Turbine.

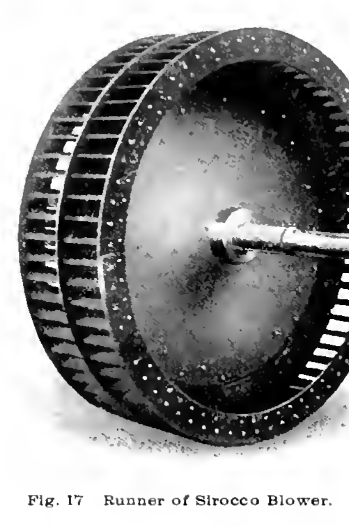


Fig. 17 Runner of Sirocco Blower.

rotation, thus insuring safety of parts of pump and pipe line.

Three centrifugal pumps were recently tested by Prof. Denton and Mr. Wm. Kent at the De Laval testing laboratory, and the results were summarized in the August number of MACHINERY. No. 1 was a single-stage machine designed to lift 1,700 gallons of water per minute against a head of 100 feet. It was driven by a 55 horse power turbine with a speed reduction of 10 to 1, and was found to require a maximum of 44½ horse power. The efficiency of the pump to the brake horse power of the turbine ranges from .743 to .756; the duty about 61,000,000 foot pounds per 1,000 pounds of steam, and the steam consumption per brake horse power about 24.25 pounds per brake horse power hour. No. 2 pump was driven by electric motor and showed similar results to the above. The third pump was a two-stage machine designed to lift 250 gallons per minute against a head of 700 feet with a large runner turning at the rate of 2,050 revolutions per minute and the small one at the rate of 20,500 revolutions per minute. This was one of the new high-pressure pumps with a small runner connected directly to the turbine shaft. The duty in million foot pounds ranges from 41.55 at a head of 494 feet to 48.88 at a head of 781 feet.

Blower Sets.

Another field where the De Laval turbine is well adapted is for direct connection to blowers for water pressures between 4 and 21 inches. The high velocity of the turbine makes it feasible to use such blower units for locations and pressures where the positive acting impeller blowers have been employed. The turbine is used in connection with blowers of the Sturtevant and Sirocco type. When directly connected to the blowers, the whole forms a compact unit, and eliminates the trouble from tight belts and heated bearings met with in attempting to use blowers for high pressures. A Sirocco blower set is illustrated in Fig. 16, and in Fig. 17 is a runner for one of these blowers. The blades of the runner are narrow and ranged around the circumference. They are concave and the runner rotates so that the concave sides lead. The theory of the blower is the reverse of the theory of a turbine water wheel; that is, the escaping air is the reverse in direction and corresponds in velocity to the jet of water which impinges against the blades of a turbine and like the jet of water has a higher velocity than either of the other components forming the parallelogram of forces acting at the edge of the blades. The air therefore has an augmented velocity with this type of runner at the point of escape which makes this type compact for a given capacity. The Sirocco blower is well adapted for the double-shaft turbine because it is of smaller diameter for a given capacity than the ordinary type; and by arranging the two blowers as in Fig 16 so they overlap in a manner similar to the arrangement of the alternating current generating set mentioned above, there is room for blowers of the required diameter for the speed at which the geared turbine shafts run. At the front of the bedplate, Fig. 16, there will be noticed a vertical cylinder, which is a regulator connected with the governor for varying the speed of the turbine slightly in order to maintain a constant air pressure. This cylinder is connected with the discharge ducts of the blowers and contains a weighted plunger which balances the air pressure underneath.

* * *

The serial articles "A Review of Steam Turbine Patents," and "Variable-speed Motors," the latter by Mr. Baxter, are omitted from this number of the paper, but will appear in the November issue.

* * *

What should prove an important discovery, if practicable, is that of a Philadelphia inventor for alloying copper with iron. Mr. Darling believes that he has discovered a process whereby a perfectly homogeneous alloy of copper and iron can be made in varying proportions up to 85 per cent. iron. An oxide of iron, either hematite or black oxide, is used, and if, for instance, a fifty per cent. alloy is wanted, three parts of oxide are mixed with one part of calcium carbide for the iron constituent; eighteen parts of this iron constituent are used with eight parts of copper. The copper is first melted in a crucible and the iron oxide mixture is slowly added a little at a time as the temperature is gradually increased.

TOOL STEEL FORGING AND TEMPERING.

Air hardening or special steel is a combination of various metals in various proportions with iron and carbon. These alloys give steel the power of holding an edge at a temperature, say, of 600 F. when the cutting edge of carbon steel is ruined. Various modes of treatment are specified or given as directions by the manufacturers, but by experiment the toolsmith occasionally treats the steel in a different manner, and gets better results. As to treatment most of these steels require the point to be slightly fused before cooling and grinding. This we would imagine turns the cement carbon to hardening carbon, and brings the outer surface up to the hardness of chilled cast iron, when under the influence of the air blast. Tools made from this steel should have short points and the steel should be of the largest section that can be used with the least possible clearance so as to conduct the heat away as rapidly as possible.

Air hardening is generally used for rough work where surplus metal has to be removed at a rapid rate and should be ground on wet grinders. Several brands of this special steel are almost unworkable or rather unforgeable. This class is not brought up to a weld at the point for the purpose of hardening, but is cooled in air blast; other brands again can be forged at the same heat as ordinary tool steel. These last are more economical to use, for when they are too short they can be drawn out for smaller work. The high prices being taken into consideration the unworkable grades are almost valueless when too short. By unworkable is meant those kinds that are used without forging, being cut off and shaped on an emery grinder. We must also bear in mind that since air-hardening steel deteriorates in heating and working at the forge, this process cannot be carried on as often as with carbon steel.

Carbon or tool steel holds a finer edge than the air-hardening variety and can be forged or worked into any shape required, and will always be used for tools required for exact work and tools urged by impact. There should be about three grades, the first for taps, milling cutters, reamers and screw-cutting dies, also for special tools used in tool making lathes; the next grade for machinists' chisels, cold sets, hammers, button sets, hot chisels, punches for machines, shear blades, etc.; the next grade for flatters, swedges, dies for working hot metals, bolt heading and forging machines. These latter can be made from open hearth steel.

Where there is a furnace for heating tools and a pyrometer to gage the heat, the tool question is reduced to a science. What is wanted is a good grade of steel for the tool required, then there is no danger of a poor tool. In making tools we must take into consideration the cost of such tools; first the cost of the steel in the bar; second, the making of the tools. A third consideration is the endurance of the tool, and taken in connection with the rate at which the tool can work determines very largely its economy. In most cases the wear and the cost of redressing and regrinding is less for tools made of high grade than of low grade steel, so that it is generally cheaper to make all tools of a good grade of steel than an inferior grade. We would remind you that at all times in forging and tempering tools it is necessary to have a good clean fire with plenty of suitable fuel between the tuyere iron and the tool to prevent the cold blast coming in contact with the tool, and to avoid too high a heat as there are more tools spoiled by overheating than otherwise.

In annealing it is impossible to avoid a slight lowering of the percentage of carbon on the surface of the annealed metal; the decarbonization takes place to a depth of 1-16 to 1/8 inch. In every case where the finished article, such as dies or cutters, is to be hardened this partially decarbonized skin should be removed before the steel is machined to finished size or shape, so sufficient stock must be allowed for this purpose when forged.

There is one great evil that is hard to overcome, *i. e.*, the many brands of steel that will accumulate in the average steel room. The tool smith may expect to find from six to ten different brands of steel, with the labels defaced, con-

* Abstract of report submitted by Mr. R. H. Henderson to the Twelfth Annual Convention of the National Railroad Blacksmiths' Association at Indianapolis, August 18, 1904.

sequently he is at a loss to know what he is using. When in doubt we know of no better way than to follow the recommendation of the committee on the treatment of high carbon steel of the eighth annual report as follows: Select the nearest size steel required for the tool you wish to make, draw the same down to a point. If this can be done without fracture you may assume the quality is good. The lowest heat that will give the desired hardness is the best, and if on breaking the point you find that the steel has a finer grain than the original bar the question of quality and temper is cheaply settled. This simple test will repay the cost many times over. If the steel manufacturers would brand their steel on the ends of the bars with their brands, also the number on each bar to denote its carbon temper—5, 6, 7 denoting 50, 60, 70 per cent. of carbon, respectively, the practice would greatly reduce the number of poor tools. When this practice is followed the tool-smith should stamp each tool where practicable with the corresponding number on the bar so that in redressing and tempering those tools they will know just what grade of steel they were handling and can govern themselves accordingly.

* * *

FROM MR. BLAKE.

Editor MACHINERY:

In reference to the articles in the last number by Messrs. Graham and Myers, in criticism of C. F. Blake's article in a previous issue upon "Beams and Planes Eccentrically Loaded and Severally Supported," we have the following communication from Mr. Blake:

"I should explain that my article was not sent as a finished, scientific treatise of the subject, but only as *one* attempt to solve a difficult problem, about which nothing could be found in a well-equipped engineering library; and I thought it time to make this explanation when the discussion I hoped for was brought out. For my own benefit I wish to see more light on the subject.

"The problem arose when we had a built-up frame of structural shapes, supported at several points and loaded at a known point: Required the reactions at supports. It was discussed by several designers and engineers, with the result as I gave it. During the discussion the claim was made that the problem was indeterminate, but that did not satisfy us, since the same reactions, if measured, would appear at each application of the load, and these reactions we wished to find, because we were up against an actual case in iron and steel, and not engaged in a fine-haired scientific discussion.

"While therefore agreeing with Mr. Graham that 'only three points are required to support a plane,' we had to look conditions in the face and could not dismiss the subject by saying that 'if more are used the division of the load is arbitrary,' because if placed by an arbitrary system, that system was not of our making, and we had to find the reactions existing, not those resulting from some arbitrary arrangement of our own. We realized that the method is only absolutely correct with a perfectly rigid body, but found no way of introducing a correction for deflections, short of a very arbitrary way, which might or might not (probably not), be in accordance with the way that nature had distributed the reactions in our particular frame. We tried, as suggested by Mr. Myers, to avoid the construction that gave rise to our troubles, but could not do so. I think Mr. Graham has not entirely made out his point in distributing the reactions. He says the particular four-armed spider shown is not in equilibrium about rectangular axes, but does not tell us where to place the origin of these axes, nor the direction of the same. Now it seems to me that the geometrical center of gravity of the supports is a point that must be recognized, and it logically becomes the origin of these rectangular axes. The direction of the axes is determined by the direction of the line joining the center of gravity of the load with the geometrical center of gravity of the supports. At any rate, as far as he goes up to this point, I have as much right to claim these as the rectangular axes as any other, and I think I am right in so doing. If this point is granted, then his spider would not be in equilibrium, while mine would. Later he *assumes* the origin at B with O B as direction, but why? It is unfortunate that I chose a four-armed spider as my illustration, since it gives Mr. Graham an opportunity to divide the load in a manner seemingly impossible with a spider of uneven number of arms, and I should like to ask him to extend his method to a spider having five arms. Mr. Graham's treatment of the subject after he has obtained his reactions seems particularly good, and is a point worth bringing out.

"I should like to see a thorough discussion of this problem, and if any can throw light upon it, I hope they will do so.

"C. F. BLAKE."

* * *

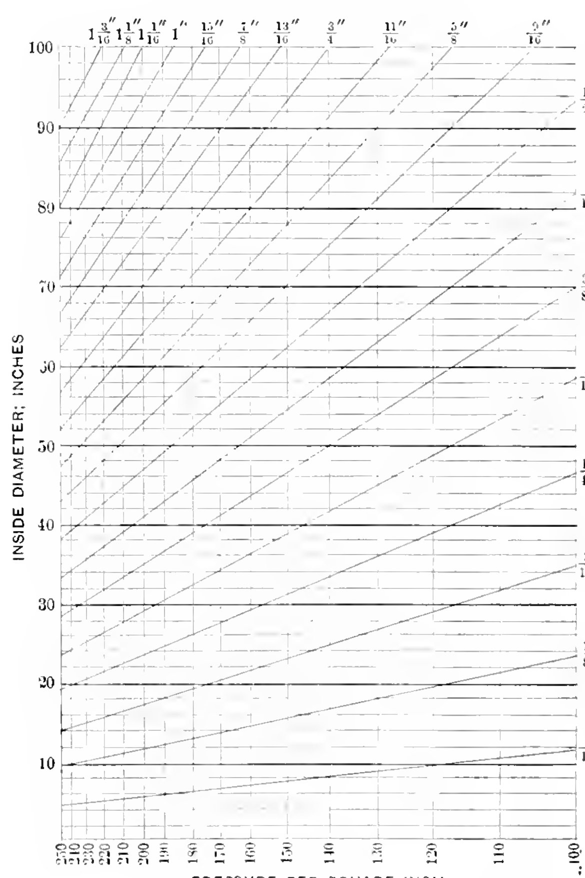
One of the useful applications of the electric motor is the operation of large valves. In the modern steam plant many of the valves are of such large size that if manually operated, two men often must be employed, and the closing or opening is slow. When electrically operated all the important valves can be wired so as to be under the immediate control of one operator. In emergencies a fraction of a minute lost in the closing of a main steam valve may mean all the difference between a trifling accident and an appalling disaster. A little wrinkle in the application of the motor to large valves, as practiced by one large electrical concern, is arranging the reducing gearing so that the motor can attain full speed before the valve begins to open. In this way a hammer blow is struck that does not fail to "crack" the valve disk loose from its seat; if the valve were made to open with the starting of the motor, frequently its torque would be insufficient to start it loose, although ample for opening it after the initial movement had been accomplished.

* * *

BOILER SHELL CHART.

The accompanying chart, contributed by Mr. A. A. Kellogg, of Green Island, N. Y., gives a graphical means of finding the thickness of boiler shell material for the cylindrical portion of locomotive or other type boilers, when the diameter and

TO FIND THICKNESS OF SHEET FOR ANY GIVEN BOILER DIAMETER: FROM INSIDE DIMENSION OF BOILER READ OVER TO RATED STEAM PRESSURE AND USE THICKNESS SHOWN BY NEAREST DIAGONAL.



steam pressure are known. It is laid out to give a nominal factor of safety of 6, with steel plate having an ultimate tensile strength of 55,000 pounds per square inch of section. The ordinates or verticals represent boiler diameters, in

inches, and the abscissæ or horizontals, the boiler pressures, in pounds. By tracing the horizontal line from any given diameter to its intersection with the vertical for the given boiler pressure, the thickness of steel plate required may be read directly at the upper end of the nearest diagonal. For example, what thickness of plate should be used for a boiler shell 80 inches diameter, carrying a pressure of 160 pounds per square inch? The intersection of the 80-inch diameter horizontal and the 160-pound vertical coincides with the diagonal representing 11-16-inch plate, which is the thickness required. Of course, steel-plate of this thickness and 55,000 pounds tensile strength would not make a boiler having a factor of 6, for the reason that the longitudinal seam is necessarily weaker than the solid plate, but such seams are now easily made over 80 per cent. efficiency, so that we can safely count on a factor of 5, which is the one commonly accepted.

* * *

THE PRACTICAL INSPECTOR.

E. N. PERCY.


E. N. Percy.

The inspector's duty is to represent his employer, and see that his employer's conditions are complied with in the most approved manner. The engineering inspector holds a responsible position, and should be, and usually is, a man of long experience and sterling character. Whether he is inspecting materials, construction, plants in operation, or steamships, he must be a specialist in his particular line in order to properly represent his employer.

Inspection begins with the raw product. Pig iron is tested by chemistry and with the microscope. It is broken, that the inspector may observe its texture, and crystallization; also, that he may note the amount of free graphite and carbon sprinkled through it. For first-class castings he should not pass any pigs full of dirt or slag. The proper mixtures of the various irons for a given class of castings must be personally seen to on any large or important work. In the manufacture of steel for forgings, castings or tools, the blistering or puddling processes are noted, and the inspector sees that all coupons for chemical and physical tests are cut actually from the rails or billets or sections they represent, and that said coupons suffer no subsequent "doctoring," tempering or annealing.

In all Bessemerized steel, he will see the blow at the converter, note that it is oxidized clean, until all colors disappear and white flame appears. He will have coupons made on important castings, and have buttons for chemical analysis cast from the same blow. He must see that these button molds are not filled with slag, or melted clay or flux instead of steel. He should also see that large castings are properly cooled, so as to have the least possible internal strain. With rolled sections, forgings and plate work, there are apt to be laminations, where scale or carbon has interfered with the welding of the different parts of a section.

Copper pig requires only the most superficial inspection, as it never contains visible impurities. Chemical analysis may show traces of silver or gold, which can do no harm. If, however, it is found to contain zinc or tin, it should not be used near salt water, without certain precautions to prevent galvanic corrosion. Tin, zinc, antimony and lead can be accepted as generally sold unless required especially pure for some particular reason. Commercially pure metal, while answering most purposes, may cost many times as much if required chemically pure.

The inspection of crude oil is a specialty not to be treated here, except as a fuel; but of its finished products in the lubricating line, we will speak later. An oil which has a specific gravity of .926 at 60 degrees F. and a flash point of 260 degrees F. will burn nicely with a little warming, and be perfectly safe. The flash point should not be below 180 degrees or better, 200 degrees. Beaumont oil, by one analysis contains 83.26 per cent. of carbon, 12.41 per cent. of hydrogen and 3.8 per cent. of oxygen. This may be considered a very rich oil and will give 19.481 B. T. U. per pound. To test for flash point, warm up a thimbleful with a thermometer in it, and note at what temperature it can be lit with a match. This should be done very quickly, or the more volatile gases will ignite first, giving an imperfect result.

To select good coal, wherever it may come from, choose the hard, shiny lumps, whose dust shines like diamonds when dry, and do not select mushy, soft, dull coal that smells of bitumen or heavy oil.

Next, after raw products, the inspector has to deal with the finished, or partially finished article. All castings require careful inspection. Look in all angles and fillets for cracks. If the iron suddenly changes thickness, test with hammer to see if the iron sounds strained. Note if workmanship is good, and if it is properly annealed or chilled, as the case may be. See that the iron has run well together at all points. Sometimes the iron will "freeze" and not come up well somewhere. There are often stream lines in cases where the iron has run, but was cool, and welded imperfectly. The casting should be of even thickness where intended. If a very tall casting, the head of iron is apt to compress the sand at the bottom and make the iron thicker there. Also, the cores will sometimes shift, or float. If chaplets are permitted, they should be tapped, to see if loose. They should be properly calked, if leaky, and should be so inserted that their edges are covered and hidden by the metal. Chaplets should be tested very carefully. The writer has in mind an over-zealous inspector who tapped on a chaplet until it was so loose it could not be fixed, and in removing it, the casting was ruined. The casting was worth many hundred dollars. Bronze and brass castings are apt to leak in cases where one crucible is poured in, and then another, and so on, where the casting is large enough to require several crucibles of material. The joining lines of these "pours" can always be seen. They may assume the appearance of a thin scale, and such "scale" on bronze castings should be very carefully examined.

Ribs and ties should be carefully tapped with a light hammer to ascertain any difference in tension. Spongy spots should be carefully considered in regard to their location, etc. If, as is an excellent plan, the more important castings are tested by hydrostatic pressure, they should be tested at about 50 per cent. more than their maximum working pressure. Wherever a fine sweat appears, that part should be marked with chalk, and pened inside until it leaks no more. Should the leaks be numerous, and fine streams of water appear in many places, and the casting show signs of distress, it must be rejected. No internal shellacing, oiling, or plugging should be allowed previous to the test. Some builders resort to many tricks in these tests. They use heavy oil instead of water, because it will not come through defective iron so easily. They cut out defective parts of castings, and insert plugs. One worthy ran the pump pipe straight through the casting to the gage prominently displayed on top. He filled the casting with water, pumped up the gage and called the inspector. The inspector thought the gage was remarkably responsive to the pump, and called an investigation. The worthy gentleman explained that "he meant to put a hole in the pipe, but forgot to." The inspector should always see that there is a "hole in the pipe."

Castings should be carefully measured, tested for roundness or straightness, and their squareness to other parts of machinery noted. Forgings are inspected for flaws, cracks, imperfect welds, burns, temper, springiness, and the coupons tested for strength. Each large forging should have two coupons taken from it—one for bending test, and one for tensile—and the inspector must see that these are not subjected to any treatment subsequent to their removal from the forg-

E. N. PERCY was for a time employed in the machine shops of the Vance Mill & Lumber Co., and then attended the Lick Technical School for three terms, taking the mechanical and scientific studies. For two years he went to sea as a junior engineer, then for two years he was with the Geo. E. Dow Pumping Engine Company as designer. He also worked for one year, as designer, for the Union Iron Works. Since then he has been inspector of machinery for the United States Government. Some of his more important work has been in connection with designs for the steamship *Whittier*, and the battleship *Ohio*; for the San Francisco Gas and Electric Co.'s plant; and some hydraulic work.

ing. Plates should be examined for laminations, cracks, blisters, buckles, thickness, scale, and general condition. Plates are apt to show cracks around punched rivet holes, or sheared edges. A blister should be drilled into, and, if merely a buckle, it can be planed out, but if laminations filled with scale show up, the plate must be rejected, unless the blister can be cut out. If plates are pickled, tempered, or put through any other process, it should be carefully noted, as more depends upon plates, and they carry greater loads in comparison to their capacity, than any other material of engineering.

The inspector himself should see all bronzes and babbitts for important castings compounded and melted. He will be present when the larger bearings are fitted, and note the oil grooves and holes and provisions for lubrication.

Coupons from forgings, castings, and plates for bending tests, shall be ½ x 1 inch by 8 or 10 inches in length. They can be bent in any hydraulic press to a radius whose length shall be determined by the qualities the metal should have. Coupons for tensile strength of iron castings and steel are round, ½ inch diameter by 3 inches long, with enlarged screw ends for testing machine. At 1 inch each side of the middle a center punch mark will be made. From these, the elongation after rupture can be measured. The reduction of area is also noted, and the number of pounds to break the coupon. This latter is changed by computation to pounds per square inch.

Boiler and machine steel run about 65,000 pounds per square inch. Nickel steel runs from 95,000 to 105,000 pounds per square inch, with 25 per cent. elongation, and 15 per cent. reduction of area. The requirements for steel change continually, and the inspector must obtain this from experience, study, instructions or specifications.

An inspector of foundations must see that the piling is full length, and driven without splintering, that the spring mat, rubble and cement are of the proper kind, that the cement contractor places the foundation bolts according to the template, and that the template is according to the engine. The foundation should be dry, and the flywheel or armature pit should have an accessible trap to sewer, with stairs down to it, if possible.

Probably the most important duty given to an inspector is the inspection of an elevator or a steam boiler, because they concern human lives. For a new boiler, it is merely filled with water, pumped up, and tested at 30 to 50 per cent. of excess pressure. If no rivets or seams leak, and stays and tubes are all sound, the boiler is emptied, and the inspector enters to sound the stays, to see that the calking tools have not grooved the plates, and that the boiler is free from mud and oil. The first time a boiler is steamed up, he sees that no oil or grease gets in from the condenser during the trial; that all rivet holes are drilled, not punched; that holes for tubes all flare properly, and that no cracked, split, or crooked tubes are used. The calking must be done by *upsetting* the corner of the plate, *not* by *splitting*. The grate bars must be suited to the coal they will burn, and of such shape that they will not warp. The boiler must be well supported, and accurately aligned. Brickwork should never take any of the boiler weight. The safety valve must be tried, its seat inspected, the weight or spring set, tested, locked and a key given to the proper party. In an old boiler, additional inspection as follows is required. 1st. Internal, for corrosion, scale, loose stays, burns, pockets, mud and thickness of metal.

2d. External, for rust, strength of supports, thickness of metal, ends of tubes, interior of furnaces and stacks. Water gages must be inspected and tested, also gage cocks. The steam gage must be calibrated, and there should be at least two ways of feeding the boiler.

3d. For all special requirements of the employer whom the inspector represents.

To inspect an elevator, first note the condition of the cables—how many ends are sticking out, how worn it is, how its terminals are secured, and how many there are. Then the sheaves should be carefully inspected. Any sheave that has a piece of the flange gone, larger than half the section of the cable, should be condemned as dangerous.

Sheave bearings and axles come next; then the motive power. If rams, see that all work smoothly. Look at the cup leathers, note if they are new, and if there are plenty on each ram. If electric, look at the worm gears, or screw, and see that neither wears too much in one place. Engineers are very apt to set up the driving nut so tight on the worn part of the screw, that when the nut reaches the newer part of screw, the ball bearings are crushed, and the elevator locked between floors.

The regulating devices must also be carefully inspected. See that the ropes are not worn, that the rheostats swing easily, and, in the case of a hydraulic plant, note the condition of the regulating valves, that they move easily, and that the main valves do not leak. The governor should be set properly, and given a thorough test at full speed.

The pumps or dynamos should be inspected to ascertain their condition and means of regulation. The air chambers, compensators, shock plungers, etc., should be carefully looked after. All elbows and tees carrying high pressure water must be thoroughly tested with a prick punch and hammer to see if the high velocity has cut them dangerously thin.

The safety appliances must be tried as nearly as possible under actual conditions. With air-cushion machines, they should at least once a year be dropped from the top of the building to test the cushion. It is not advisable for the inspector to ride during this test, but he might invite the maker of the elevator to do so.

The inspection of wood for engineering purposes is a specialty belonging to the expert lumberman, but an inspector can assure himself that it is of good quality, straight grained and free from knots. If it is chosen for lagging, he need look but for beauty alone.

He must learn to know the good and bad qualities of paint, varnish, oil, lubricants, glass, packing, tools, rubber, pumps, stokers, auxiliary machinery and all supplies for the engineer. This comes only from experience and wide reading.

The inspector is made use of and employed by insurance companies, buyers of machinery, steel companies, governments, navies, and all who buy or build machinery.

* * *

One of the strange features of mining is the existence of subterranean fires that have raged in abandoned coal mines for many years. One of these burning mines is the Greenwood Colliery, near Wilkesbarre, Pa. It has been burning for nearly fifty years and, so far, has resisted all attempts to quench it. Flooding with water is not effective, partly because the burning vein is above the natural water level, but largely because the imprisoned air and gas prevent the water reaching the fire. A determined effort is now to be made by the company to quench the fire, and drill holes have been bored, through which water charged with culm will be pumped in in vast quantities. The culm fills the vacant spaces of the mine, although the water may escape, and being wet it smothers out the fire. It also hardens in time, forming a mass practically as a solid vein of coal, and in this way the roof is supported so as to prevent the cave-ins which are a disastrous feature of these subterranean fires, especially in settled sections.

* * *

Referring to the model of the new quadruple-screw Cunard steamers exhibited at the Louisiana Purchase Exposition a correspondent of the *Scientific American* says: "Of course the model that attracts the most attention is that of the new 25-knot, 40,000-ton turbine steamers. . . . For reasons which can well be understood in this age of keen competition, the company has not seen fit to place upon the placard of this model any of the dimensions, etc." Certainly not! If the company had been so unwise as to put those dimensions on a placard where all the public could have seen them, every Tom, Dick and Harry would be building 25-knot turbine steamers and thus put the old established steamship companies out of business! As a matter of fact there is a lot of popular nonsense believed about business secrecy and the value of ideas. Ideas and knowledge are of little value unless they have the backing of capital and business push.

* * *

The index for Volume X of MACHINERY, (1903-4) is now ready and a copy of it will be sent to any subscriber requesting same. In writing please state whether the Index for the Shop Edition or the Engineering Edition is desired.

ESTIMATING COST, WITH EXAMPLES ILLUSTRATING APPLICATION OF METHOD.

JAMES A. PRATT.

James A. Pratt.

In the March issue of your journal I note an inquiry for methods of estimating cost, and offer the following as a good method, provided one has a knowledge of the work from the shop standpoint. If not he can hardly expect to do much in the way of estimating, in spite of the fact that many practical shop men are not good judges of time required to perfrom work.

The complete estimate of the cost of a machine will require an examination in detail into the cost of all the separate items such as patterns, castings, forgings, steel or brass rods, bolts, screws, etc., the various machining operations, and finally the cost of running the shop, offices and other fixed charges. If a number of similar machines are to be built, the cost of the patterns will not be so prominent an item as where only one is to be put up, in which case it may form a large percentage of the total cost. The estimating of the cost of patterns will require the cost of lumber and all other materials which enter into the construction of both patterns and core boxes as well as the cost of labor; and a knowledge of the men and their ability, as well as the machines that are available is of importance to the one making the estimate. He must also have a knowledge of pattern work, and should be able to decide as to the most economical methods in this line. Each operation must be gone over carefully in the mind, such as sawing, turning, planing, trimming, gluing, filleting, etc., and the more minute the examination the more accurate will be the estimate. It will be a good idea to note whether the methods in mind when making the estimate are being carried out in the shop; and if slower ones are used a change should be made, for it requires eternal vigilance on these points to keep a shop up to date.

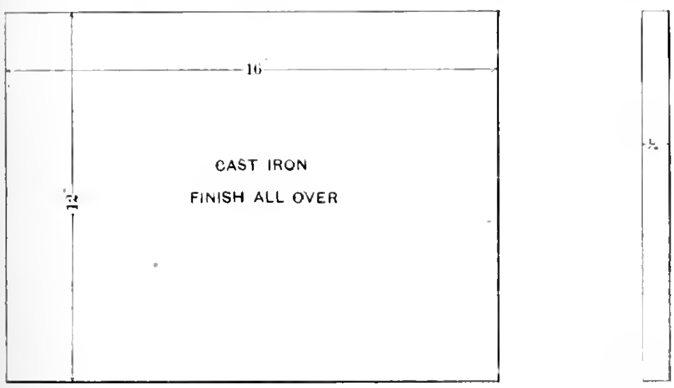


Fig. 1.

Next to the patterns will come the castings, and of these we will require as many sets as there are machines to be built. The weight of castings must be calculated and is readily obtained from the drawings by dividing each part into simple geometrical form, getting their volumes and from this estimating the weight. Almost all machine parts can be divided into a combination of forms of this sort and easily computed. This may be done in several ways by approximate methods, which save time and give results near enough for all practical purposes. Methods of estimating weights would, I think, be a subject well worthy of attention from contributors, but nothing of that sort is here offered, as the object of this article is confined to methods of estimating cost. After calculating the weight of the castings about 10 or 15 per cent. should be added for errors, finishing, etc.

On machine work the same process is followed as in the pattern estimate; that is, each operation must be gone over in detail, such as drilling, turning, boring, tapping, planing, etc., as well as a consideration of the time it will take to set a piece on a machine. Of all these except the setting a very accurate estimate may be obtained by calculating. Take turning a certain portion, for example. We know the surface speed that may be run, as well as the feed per revolution and the length of the piece, so can easily calculate how many chips will be taken to finish; hence, by a little figuring we may get a satisfactory result. The same is true of all other machine operations, but when we come to the setting up it must be entirely a matter of judgment.

A very important thing in working up an estimate, especially of machine work, is to see what special tools are available, and whether or not any new ones must be made; for if so, these must be reckoned in with the job, since it is desirable to clear a profit over all expenses. If a new tool to be made is one which can be used for general work after the job is done, we may be a little lenient and permit a part of the cost to be entered against the shop equipment; but the job directly in hand should bear the brunt of the burden of new special tools. Each tool should be considered as working at its maximum rate, and the work placed on each machine to the best advantage; that is, a job which can be done most advantageously on a turret lathe should not be put on an engine lathe, and one which can be placed to best advantage on a horizontal boring mill should not be put on an upright. At the present time the high speed steels should be considered, as a marked economy may be effected on all machine operations by their use; and wherever forged tools are used the high speed steels have a clear advantage.

If each operation is followed in detail, it is a comparatively easy matter to get the time on a job, and too much stress cannot be laid on the importance of going minutely through the making of every part of a machine, and assigning a certain time for each operation. The conditions under which the work will be done should not be assumed too favorable, as more or less time will be spent in looking for bolts, waiting at the tool room, reading drawings, and attending to the machine, all of which things increase the time but do not advance the work. The possibility of accidents should be considered also. I am aware that in some shops estimates are made, and the liability of accidents not considered, but such losses, when they occur, are charged against the profits. I think this should be considered as part of the cost of a job, as when we have made our estimate on the basis outlined the profit will come in as a clear item, and not mixed with any other considerations. The amount added for these things may be a very small percentage of the total cost, since it is covered by a number of jobs, all of which help to carry this burden.

After estimates on patterns, castings, and machine work have been made, take up shop expenses, such as rent, taxes, insurance, supplies, as well as the non-productive labor which must be employed. The running expense of the shop for a day is easily determined, and such an amount should be added as will permit the job in hand to bear its just share of the shop expense. The profit may now be added as a clean quantity, since everything has been considered by itself; and it is quite important that it be so viewed, since if it has to cover items not individually considered, one is very apt not to make it large enough, and the contract becomes a losing deal. In the above notes I have assumed that the machine has never before been built in the shop and that the estimate is being made directly from the drawings.

As an illustration, let us estimate cost of pattern, castings, and machine work on three planed bench plates, as shown in Fig. 1. The pattern will probably be made up of a main body and two end pieces, dowelled and screwed together. It is assumed that 1-inch stock is at hand from which to make the pattern.

James A. Pratt was born at Chelsea, Mass., April 6, 1873. He was graduated from school at 16, and entered a business office for two years. He then went to the Providence Engineering Works as apprentice and served four years. During this time, under the direction of a tutor, he took the regular course in mechanical engineering as offered at Brown University. His experience has covered the building of engines in the shop; erecting on the road; machine tools; special machinery; and jigs, fixtures and fine tools. At present he is instructor in machine work and mechanical drawing at the Sockanosset School for Boys, Howard, R. I. Mr. Pratt is a senior member of the Providence Association of Mechanical Engineers, and has contributed to several technical journals.

Getting out and sawing lumber	10 min.
Trimming ends	5 min.
Getting out end pieces and placing same	20 min.
Finishing pattern	15 min.
Surfacing cuts on different pieces	10 min.
Total working time	60 min.

This allows for actual working time only, but there will be more or less time indirectly spent which we must consider. To cover this, call total time on the whole job one hour and thirty minutes, which at 28 cents per hour equals 42 cents.

Next come the castings, of which three will be required. Proper allowance having been made in the pattern for shrinkage and finish, each plate will be $12\frac{1}{4}$ inches $\times$ $16\frac{1}{4}$ inches $\times$ $\frac{3}{4}$ inch. Taking $\frac{1}{4}$ pound as the weight of one cubic inch of cast iron, which is sufficiently accurate in this case, the calculation of the weight is readily made as follows:

$12\frac{1}{4}'' \times 16\frac{1}{4}'' \times \frac{3}{4}'' \times 3 \times \frac{1}{4}$ lb. = weight of three plates or $\frac{49''}{4} \times \frac{65''}{4} \times \frac{3''}{4} \times 3 \times \frac{1}{4}$ " $= \frac{28665}{256} = 112$ lbs —say 115 lbs., which at 2 cents per lb. will cost $2.30

Considering now the machine work. We have a plate $12\frac{1}{4}$ inches wide, $16\frac{1}{4}$ inches long and $\frac{3}{4}$ inch thick to reduce to $12 \times 16 \times \frac{1}{2}$. Assume that we take one rough and one finish cut with a roughing feed of 1-16 inch and a finishing feed of $\frac{1}{2}$.

Since plate is $12\frac{1}{2}$ inches wide and we take 1-16 inch at each cut we will need $12\frac{1}{2}$ inches $\div$ 1-16 inch, i. e., 200 cuts, and as each cut is 16 inches long the planer bed must travel $200 \times 16 = 3,200$ inches to get over the surface once. It must also travel the same distance for the return.

Speed of planer on cut 24 feet per minute = 288 inches.

Return of planer 48 feet per minute = 576 inches.

Hence we have need for cuts $\frac{3,200 \text{ inches}}{288 \text{ inches}}$ or 11.10 minutes and as the return speed is double the forward—one half as much time will be required for the return. Let us call the time for the cut 12 minutes and for the return 6 minutes. Now the planer will take some time to reverse at each end of stroke and for this we will allow 7 minutes. Cutting on sides of plate will require 3 minutes, with two minutes each for reverse and return, making 7 minutes for sides. Cuts on ends of plate will take one minute each for reverse and return, or three minutes for the ends, which makes a total for roughing cuts on one face and all sides, of thirty-five minutes; and as we have this on three plates, 105 minutes will be required for roughing one face and all sides and ends. We must also surface the other face of the plates at 19 minutes each, which makes 57 minutes more, or for roughing cuts throughout, 162 minutes. For finish cuts on all faces and ends we have, using the same method of figuring surface, but $\frac{1}{2}$-inch feed—33 minutes, which makes the total time 195 minutes, or 3 hours 15 minutes, which we will call $3\frac{1}{2}$ hours. For setting the first plate in the planer we will allow as follows: Getting and placing rib piece, 10 minutes; setting work, 10 minutes; clamping down, 15 minutes—a total of 35 minutes. For the other two plates we will allow 20 minutes each, as they will go quicker, which makes a total of 75 minutes for all three. For the second face we will allow 15 minutes, and for the ends and sides 45 minutes, which gives a total for setting, for all the roughing cuts, of 2 hours and 15 minutes.

Coming now to the setting for finishing cut we will make allowances as follows: Removing step plate and clamps and resetting plate, 12 minutes; getting bolts and clamping first plate, 17 minutes; for the other two plates, 10 minutes; for the second face, 15 minutes; a total of 54 minutes—say, one hour. Then we will allow for grinding and setting tools, and adjusting feeds, two hours; and finally for cleaning machine one half hour. This makes 5 hours and 45 minutes for setting grinding tools, etc., which we will call 6 hours. With the $3\frac{1}{2}$ hours for the cutting time we now have $9\frac{1}{2}$ hours. Adding for attention to machine, risk, etc., say, 5 per cent., and we have a trifle less than ten hours.

This assumes that the workman does not stop for any purpose whatever, but is constantly at work. As this is not possible, we may safely add one hour for time spent indirectly on the job, which gives us a total estimated time of 11 hours, which at 28 cents per hour is $3.08, making a total estimated cost of $5.80.

The actual time required to run this job off was 11 hours 25 minutes, showing that I was short on my estimate, but as two of the plates came from the foundry chilled, considerable time was lost in getting the work started, three tools being spoiled and one broken before work was really begun.

The average price for such jobbing work is 50 cents per hour for patternmaker and machinist, and for castings $3\frac{1}{2}$ cents per pound. Calculating on this basis, our estimate would stand as follows:

Patternmaker, 1 hour 30 minutes, at 50 cents	$ .75
Machinist, 11 hours, at 50 cents	5.50
115 pounds castings, at $3\frac{1}{2}$ cents	4.02
	$10.27
Estimated cost	$5.80
Leaving a surplus of	4.47

from which must still be deducted the proportionate part of the general shop expense before referred to, before we get down to the net profit.

As a second illustration of cost estimating, let us take up the cone pulley shown in Fig. 2. The pattern on this job was solid and the core box of the skeleton type. The core box is shown in Fig. 3 in order to make clear the references to it.

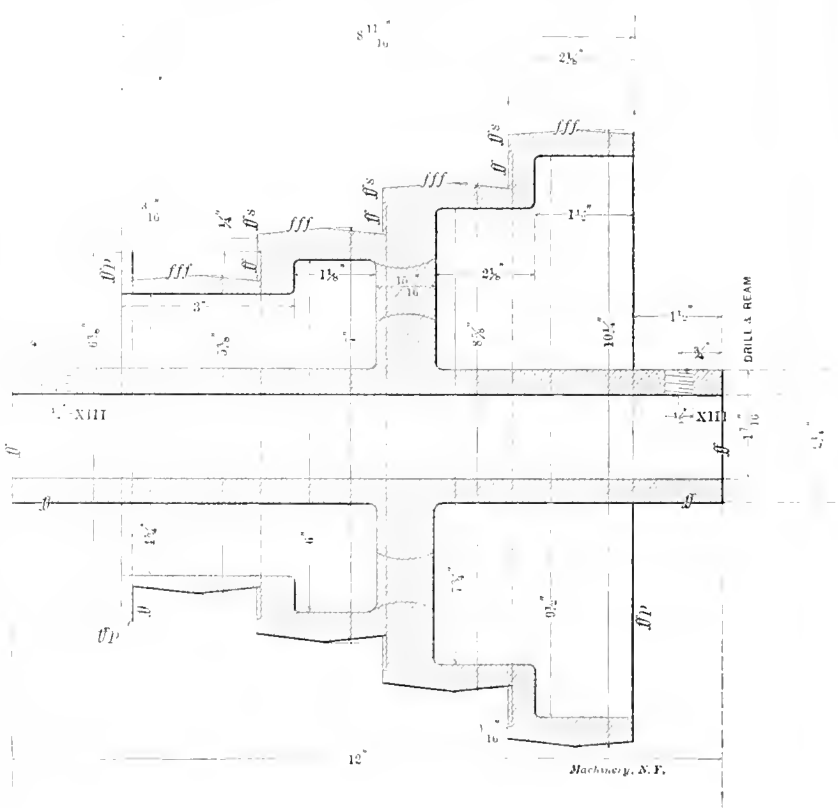


Fig. 2.

The pattern will be made up of a series of disks of $\frac{3}{4}$-inch stock glued together and turned, and large core prints $1\frac{3}{8}$ inches thick must be placed at each end. The flange shown in the drawing is left loose on the pattern for convenience in drawing the pattern from the sand. Estimated by items as below we have:

Getting out and sawing stock for pattern complete	60 min.
Planing up stock	45 min.
Laying out and bandsawing	60 min.
Gluing up	25 min.
Turning small core prints	20 min.
Turning pattern and sanding	60 min.
Placing prints and finishing pattern	20 min.
	290 min.

Total time on pattern, 4 hours 50 minutes.

Indirect time, ½ hour, making 5 hours 20 minutes—say 5½ hours.

Core Boxes.

The small core will be a "stock core," and no core box will be needed. The core for the larger part we will make of the skeleton type and sweep up in four quarters, these being afterward pasted together for use in the mold. Again estimating by items we have:

Getting out sides complete	107 min.
Getting out and attaching ends	25 min.
Getting out and placing barrel	20 min.
Getting out two shoulder pieces	30 min.
Doweling shoulder pieces and baffle board	40 min.
Getting out baffle	25 min.
Shellac	15 min.
Striko board	20 min.
Total	282 min.

Total time on core box complete, 4 hours 42 minutes.

Total time on pattern, 5 hours 30 minutes.

Total, 10 hours 12 minutes.

To cover indirect time, call estimate on pattern and core box 11 hours.

The next thing for consideration is the weight of the casting. We will take the hub as a cylinder 12 inches long, 2½ inches diameter, with 1¼-inch hole through it—44 cubic inches; the central web as a ring 7¾ inches diameter, ⅞ inch thick, and 2½-inch hole—37 cubic inches; the small step as a ring 5½ inches diameter, 3 inches long and a 5-inch hole—11.50 cubic inches, etc., using the same method in getting the whole volume, viz., divide it into a series of rings and get the volume. Adding these together and multiplying by .25 pounds (the weight of a cubic inch of cast iron) the calculated weight is 46 pounds. Add 10 per cent. for errors and variation, and we have approximately 51 pounds. The actual weight of this casting was 52 pounds.

In connection with the machine work, the first thing to be done is to look over the machines in the shop and see if any special tools are needed. This is very important, as at times work may be taken up which is larger than a machine can conveniently handle, and it will be necessary to make some alterations. We find nothing of this sort to be done on this particular piece, but we will need a long arbor, which we will charge entirely to the job. Those who wish might take part of the cost of the arbor off, since it can be used for other purposes after this particular piece of work is done.

Finding we have an arbor 1⅝ inches diameter and 16½ inches long, we will turn it down for this job. Being already centered we will not have to allow for that, so the time will be as follows: The coarsest feed of the lathe to be used is 1-100 inch per revolution, and we will take two roughing cuts with the lathe running 130 R. P. M.

The lathe must make 1,650 revolutions in going the length of the arbor and will take $\frac{1650}{130} = 13$ minutes for each of two roughing cuts, making:

Roughing time	26 min.
Finishing chip at 160 R. P. M.	11 min.
Filing and fitting	45 min.
	82 min.

Total 1 hour 22 minutes. Call this 1 hour 30 minutes.

Coming to the machine work on core, we have drilling at 94 R. P. M., surface speed 35 feet per minute. Piece is 1 7-16 inches diameter = 23-16; 23-16 × 3.14 = 4.5 inches circumference. As the surface speed is 35 feet or 420 inches per minute, and as a point on the circumference travels 4.5 inch at each revolution, we must make $\frac{420}{4.5} = 94$ R. P. M. Feed 1-32 inch per revolution will need 32 revolutions to go 1 inch, and for 12 inches, the length of the hub, we need 12 × 32, or 384 revolutions to go through the hub once, and it will take $\frac{384}{90}$ = 4 + minutes. Call this 5 minutes for roughing and 5 minutes for finishing, we have 10 minutes. This is provided casting comes soft and homogeneous. It may come hard with blow holes, causing grinding of drills, etc., and to cover these possibilities we call

Time	20 min.
Squaring down cone faces	25 min
Squaring inside of flange face	10 min.
Spotting down to crown size on cone steps	24 min
Turning cone steps 2½ inches long, feed 1-100 inch per revolution, will need 213 revolutions at 22 R. P. M., and will take	10 min.
Three chips on each step, and assume all steps same size, we would need about 120 minutes; but we can speed up on smaller steps and may call	
Time	100 min.
Undercutting on cone faces	30 min.
Squaring and turning left side of hub and flange	15 min.
Scraping, filing and polishing	85 min
Drilling and tapping for setscrews	20 min

The above deals only with the actual cutting time. We must now take into account the setting and grinding of tools and other incidentals.

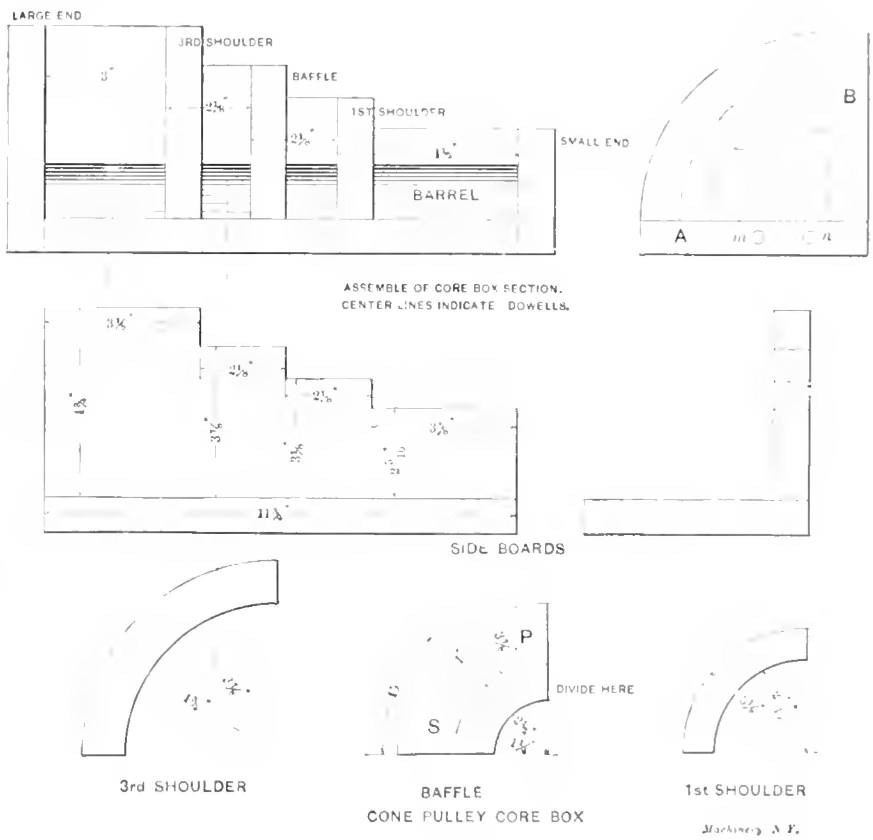


Fig. 3.

Getting out chuck, placing cone, truing up, getting drills at work, changing same, removing chuck and drills, returning tools and getting cone on centers ready for turning, say	55 min
Grinding and setting tools for squaring faces, spotting cone steps, crowning, undercuts on faces, ends of cone, and setting taper attachment	137 min
Allow for indirect time	60 min

A helper will be needed for a short time on this job, and we

Add half an hour workman's time	30 min
Cleaning machine	15 min
Making altogether	711 min

To which we will add

3 per cent. for risk, attention to machines, etc	21 min.
Giving a total of	732 min

Or 12 hours 12 minutes, which we will call 12½ hours.

The actual time on this job in the machine shop was 11 hours 30 minutes.

Combining the items, we have as the total estimated cost:

Patternmaker, 11 hours, at 28 cents	$3.08
52 pounds castings, at 3 cents	1.56
Machinist, 12½ hours, at 28 cents	3.50
	$8.14

Castings of this sort in small lots will sell at about 4 cents per pound, and calculating on this basis our estimate would be as follows:

Patternmaker, 11 hours, at 50 cents	$5.50
51 pounds castings, at 4 cents	2.04
Machinist, 12 hours 30 minutes, at 50 cents	6.25
Total	$13.79

The same items mentioned in previous case must be considered here before profit appears.

It will be noted that the surface speed was calculated for the drilling operation; but this was done simply as an illustration, and is entirely unnecessary in practical work, as tables are published which give surface speed for diameters making certain number of revolutions per minute. One very convenient table which the writer has used was published with the May number of MACHINERY in 1903.

There will be noted a slight difference in the dimensions used in estimating weight and those given in the drawing. This is done to allow for stock and variations in casting.

[While the criticism may perhaps be made that our correspondent has not selected throughout his examples at all times the most economical methods of doing the work, his analysis of the various operations in detail is quite careful and complete, and we think well illustrates such problems as small shops with limited equipment are often called on to handle. A large number of our readers, particularly among the younger men, will find the article suggestive and of much value.—EDITOR.]

* * *

NOTES ON ISOMETRIC PERSPECTIVE.

Mr. Robert S. Brown, secretary of the New Britain Machine Co., New Britain, Conn., sends a sheet of data upon the isometric system of perspective, which is reproduced herewith. He says in explanation: The bulletin print of information on isometric perspective has been issued for the drawing room force of our company. This is presented to the men in lieu of the Farrish treatise on the subject, now somewhat out of date. The Honey method referred to, for determining approximate arcs for constructing any proportion of ellipse, is the closest and quickest the writer knows of. It is in such general use among our draftsmen that nothing more than a reference to it is given on the print.

Isometric Perspective.

Based on placing objects, as the cube (Fig. 1), so that the eye is on a line with the diagonal of the cube. Each of the three visible plane surfaces then appear of same size, bounding lines as A B, B C, C D, of equal length, and extending either vertically or 60 degrees from the vertical to right or left. The angle at which cube is tipped to give this is 35 degrees, 16 minutes from horizontal.

It is customary to measure directly upon co-ordinates A B, B C, or C D, using full-sized scale. This makes each dimension of drawing 22½ per cent. longer than it would appear in a true projection of the object in isometric position.

Exact Construction for the Isometric Ellipse.

Draw both center lines A C, B D, and the circumscribing rhombus (Fig. 2). From point of rhombus at A, erect 45 degree line. A circle with center at center of rhombus and radius tangent to 45 degrees line, will, when continued across center line of rhombus, give major axis of ellipse. The minor axis can be found by 30 degree lines E F, G H. Isometrical diameter lines J K, L M, give four other points on the ellipse, and more if desired may then be located by any of the well-known methods.

Approximate Construction for Isometric Ellipse.

Draw circumscribing rhombus with sides to scale (Fig. 3). With center at B and radius of circle tangent to A D, at its mid-length, draw the long arc tangent to A D, and C D. With same radius and D as center, draw arc tangent to A B, and B C.

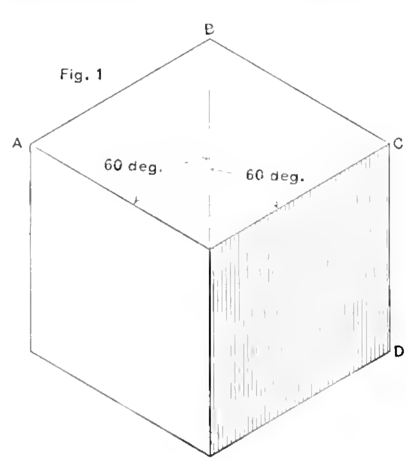
Above construction fixes length of minor axis and will vary from the actual about 0.2 inches to full in an ellipse of 10 inches major axis. Sweeping minor axis so found across major axis, gives approximate location of centers, which will finish the ellipse. These centers will be a trifle outside of the circle, but error may be neglected in small work. A close approximation to length of major axis (making same about 0.06 inch too full in 10 inches length) is had by taking ¼ of co-ordinate A B, and sweeping it across major axis with A as center.

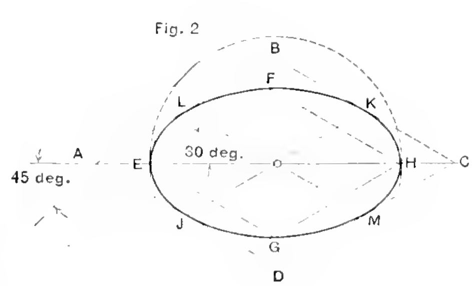
This is useful in locating ellipse from the perimeter rather than center (see Fig. 4), for construction of tangent ellipses of same size.

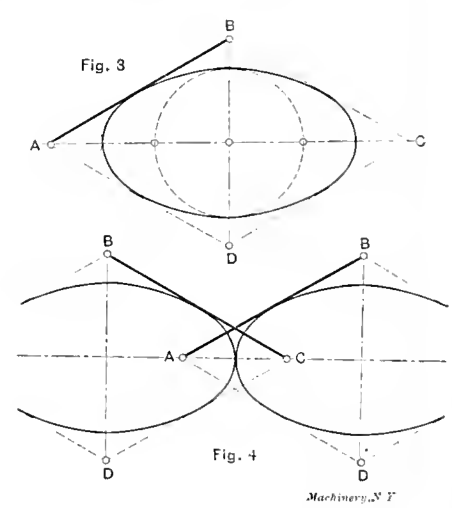
If closer results than the above are required, use method in Fig. 2 for actual major and minor axis, and construct ellipse on the Honey plan. (See Kent, page 47, 5th edition.)

Proportions of Isometric Ellipse.

Isometric Diameter.	Major Axis.	Minor Axis.
1.0000	1.2247	.7071
Log. .00000	.08805	$\bar{1}$.84949
.8165	1.0000	.5774
Log. $\bar{1}$.91195	.00000	$\bar{1}$.76144
1.4142	1.7321	1.0000
$=\sqrt{2}$	$=\sqrt{3}$	$=\sqrt{1}$
Log. .15052	.23856	.00000







SOME CASES OF DIFFERENTIAL GEARING.

A. B.

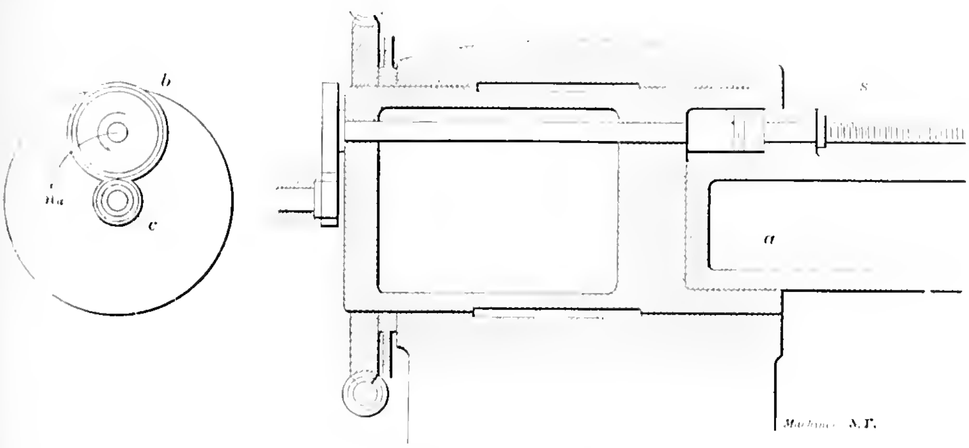
The subject is not a new one but a little study of it, and deriving suitable formulas, will be of interest to those who have not looked into it before.

The principle of differential gearing consists of a gear rotating around another gear, thus creating a ratio. This principle may be used in arrangements which differ in the way the gears are working, giving accordingly different results. Beginning with the simplest one, we take a gear on a crank rotating around another gear, and Fig. 1 (next page) illustrates this case. The bar a of a cylinder boring machine carries the feed screw s for the boring head. On the end of this screw is keyed gear b, which rotates with the bar around gear c. Gear c is a stationary gear, but as b rotates around it,

gear c acts as the driver, whilst gear b is the driven gear. Gear c has t_c and gear b has t_b teeth. Now in order to find the feed of the boring head per turn of the bar, we should know the revolutions of the screw per turn of bar. Instead of the bar making one revolution to the left we may suppose that gear c makes one revolution to the right, whilst the bar stands still. This will have the same effect for the screw. The ratio between gear c and gear b is $\frac{t_c}{t_b}$, so that for one revolution of the bar, the screw makes $\frac{t_c}{t_b}$ revolutions and for n_a revolutions per minute of the bar, the screw makes

$$n_s = n_a \times \frac{t_c}{t_b} \text{ revolutions per minute.} \qquad (1)$$

Gear b and with it screw s turns in the same direction as bar a.



Some Cases of Differential Gearing.

Example: Let the pitch of screw s be 1-3 inch and the feed of the boring head per turn of bar 1-12 inch. This means that the screw makes one-quarter of a turn for one turn of the bar. Then the ratio in the gears is

$$\frac{1}{4} = \frac{t_c}{t_b}$$

Another case is when gear c is connected to the main drive of the machine and therefore revolves too.

Then two considerations are possible: that gear c revolves in the same direction as the bar or against it. See Figs. 2 and 3. When c rotates with bar a, so are the relative rotations per minute of b around c, $n_a - n_c$ and the revolutions per minute of the screw

$$n_s = (n_a - n_c) \times \frac{t_c}{t_b} \qquad (2)$$

Screw s turns in the same direction as bar a if $n_a > n_c$; and in the opposite direction if $n_a < n_c$. In the latter case n_s has a negative value.

Example: As before the pitch of the screw is 1-3 inch and the feed per turn of bar is 1-12 inch but c makes 4 revolutions per minute and bar a makes 2 revolutions per minute. Gear c revolves in the same direction as bar a.

Question: What is the ratio for the gears c and b? For one turn of bar a, the screw has to make one-fourth of a turn, and therefore the number of revolutions per minute of the screw is

$$n_s = \frac{1}{4} n_a$$

From formula (2) we get

$$\frac{t_c}{t_b} = \frac{n_s}{n_a - n_c} = \frac{\frac{1}{4} n_a}{n_a - n_c} = \frac{\frac{1}{4} \times 2}{2 - 4} = -\frac{1}{4}$$

The negative value of this ratio shows us that the screw revolves against the direction in which the bar turns.

The other consideration of this case was that gear c revolves against bar a, and the relative rotation of gear b around gear c is then

$n_a + n_c$. See Fig. 3.

Herewith are the revolutions per minute of screw s

$$n_s = (n_a + n_c) \frac{t_c}{t_b} \qquad (3)$$

and the screw revolves always in the same direction as bar a, because n_s has always a positive value.

Another arrangement is shown in Fig. 4. The driving member in this case is a cone pulley which carries a stud with a couple of gears running loose on the stud. These two gears f and g, however, are keyed together and the stud rotates with them around the gears e and h. Gear e is fixed to some part of the frame and gear h is keyed on shaft i. The cone pulley d runs loose on shaft i.

The question here arises: How many revolutions does shaft i make for one revolution of the cone pulley? The problem is a little more complicated, as we use here four gears. In order to make it well understood we will take first the four gears have an equal number of teeth. Further, instead of revolving the cone pulley once to the left around the fixed gear e, we suppose this gear to turn once to the right whilst the cone pulley remains stationary. Then through e, f and g—h will make one revolution and, like e, to the right. But the gears on the stud were not stationary and they made one revolution around gear h to the left, with the result that gear g rolled off on gear h instead of turning the same. In other words, h makes one revolution less than the ratio between e and g would indicate. Now if the gears are not all equal we reason in the same way. Suppose gear e makes one turn to the right instead of the cone pulley d making one turn to the left, and the latter remains stationary, then gear h makes

$$\frac{t_e}{t_f} \times \frac{t_g}{t_h} \text{ revolutions.}$$

This, however, is not so, as the stud rotates around gear h and as before, gear h makes one revolution less or

$$\frac{t_e}{t_f} \times \frac{t_g}{t_h} - 1 \text{ revolutions.}$$

t_e, t_f, t_g and t_h indicate the number of teeth of the gears, and for n_d revolutions per minute of the cone pulley, shaft i makes

$$n = n_d \left(\frac{t_e}{t_f} \times \frac{t_g}{t_h} - 1 \right) \qquad (4)$$

Fig. 2.

Fig. 3

Shaft i rotates in opposite direction to cone pulley d if

$$\frac{t_e}{t_f} \times \frac{t_g}{t_h} > 1$$

Shaft i rotates in the same direction as the cone pulley if

$$\frac{t_e}{t_f} \times \frac{t_g}{t_h} < 1$$

In the latter case we see that n has a negative value indicating that shaft i and cone pulley d turn in the same direction and in the first case the sign for n is positive, indicating opposite directions.

Thus far, gear c was a fixed gear and the cone pulley with the stud only, the rotating member. Now let us examine the

case when both gear e and cone pulley d rotate. Gear e is then keyed on shaft k, by which it is driven.

We first take gear e revolving in the same direction as the cone pulley and the question is now: What is the ratio between shaft k and shaft i? We split this case in two and observe the results which we get for one revolution of d with e fixed, and for one revolution of e with d fixed, and after this we add the two results.

One revolution of d with e fixed gives us as above

$$\frac{t_e}{t_f} \times \frac{t_g}{t_h} - 1$$

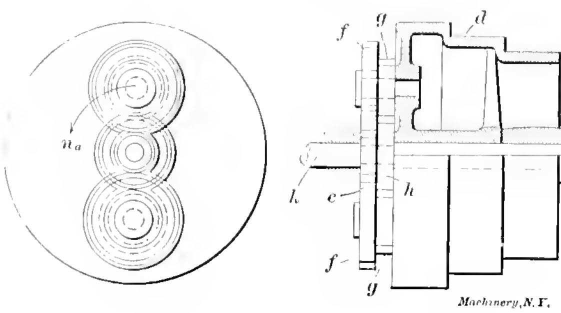


Fig. 4.

and one revolution of e with d fixed gives us

$$-\frac{t_e}{t_f} \times \frac{t_g}{t_h}$$

The value of this must be taken negative because gear e revolving in the same direction as cone pulley d forces shaft i to run in this direction also. The two results added give us

$$\left(\frac{t_e}{t_f} \times \frac{t_g}{t_h} - 1\right) - \frac{t_e}{t_f} \times \frac{t_g}{t_h}$$

and for n_k revolutions per minute of shaft k and n_d revolutions per minute of cone pulley d we get for shafts i

$$n_i = n_d\left(\frac{t_e}{t_f} \times \frac{t_g}{t_h} - 1\right) - n_k\left(\frac{t_e}{t_f} \times \frac{t_g}{t_h}\right) \text{ revs. per min.} \quad (5)$$

If n_i has a negative value shaft i turns with the cone pulley and shaft k in the same direction; and if n_i has a positive value shaft i turns in the opposite direction to the cone pulley and shaft k.

Now let us see what happens if gear e revolves against cone pulley d. In this case everything is as above except the sign for shaft k, which will be positive instead of negative, because shaft i is forced by the rotation of e to run in opposite direction to the cone pulley and the formula for n_i is

$$n_i = n_d\left(\frac{t_e}{t_f} \times \frac{t_g}{t_h} - 1\right) + n_k\left(\frac{t_e}{t_f} \times \frac{t_g}{t_h}\right) \text{ per minute.} \quad (6)$$

If n_i has a negative value shaft i turns with cone pulley d in the same direction but against shaft k. If n_i has a positive value shaft i turns against the cone pulley but with shaft k. Example in figures:

Cone pulley d makes $n_d = 20$ revolutions per minute.

Gear e with shaft k makes $n_k = 40$ revolutions per minute and turns in the same direction as d.

Gears e, f, g and h have respectively 12, 28, 14 and 26 teeth. The number of revolutions per minute of shaft i is then

$$n_i = 20\left(\frac{12}{28} \times \frac{14}{26} - 1\right) - 40\left(\frac{12}{28} \times \frac{14}{26}\right) = -24.6 \text{ revs. per min}$$

The negative sign indicates that shaft i revolves in the same direction as cone pulley d and shaft k.

* * *

A HANDY TOOL FOR LOCATING AND ALIGNING SHAFTING AND MACHINERY.

WM. H. BROOKS.

During a recent pilgrimage into archæological methods of doing things I found a new tool for helping along an old job. It was dug up from the bottom of a tool chest and is intended to be used for lining up shafting, machinery, etc. The tool is simple, accurate and inexpensive, and will beat the work of those millwrights addicted to the use of sticks, stones and strings, not to mention nails, wires and full size "chalk prints" on the floor, as well as a great variety of mental gymnastics that would make Euclid blush with shame and mortification.

The body of the tool, Fig. 1, consists of an inverted V marked A in the cut, about 6 inches long and having at the center a spot b about 2 inches in diameter finished perfectly parallel with the horizontal plane of the inverted V and having one line parallel with the V and one at 90 degrees to it, both passing through the center of the spot. Pivoted at the intersection of these two lines rests a dial, c, graduated to 360 degrees and bearing a suitable form of sights or telescope d, similar to that of a surveyor's transit; this latter of course being parallel to the base of the dial and its sight line parallel to the 0 degree and 180 degree lines. A level, e, integral with the sights or

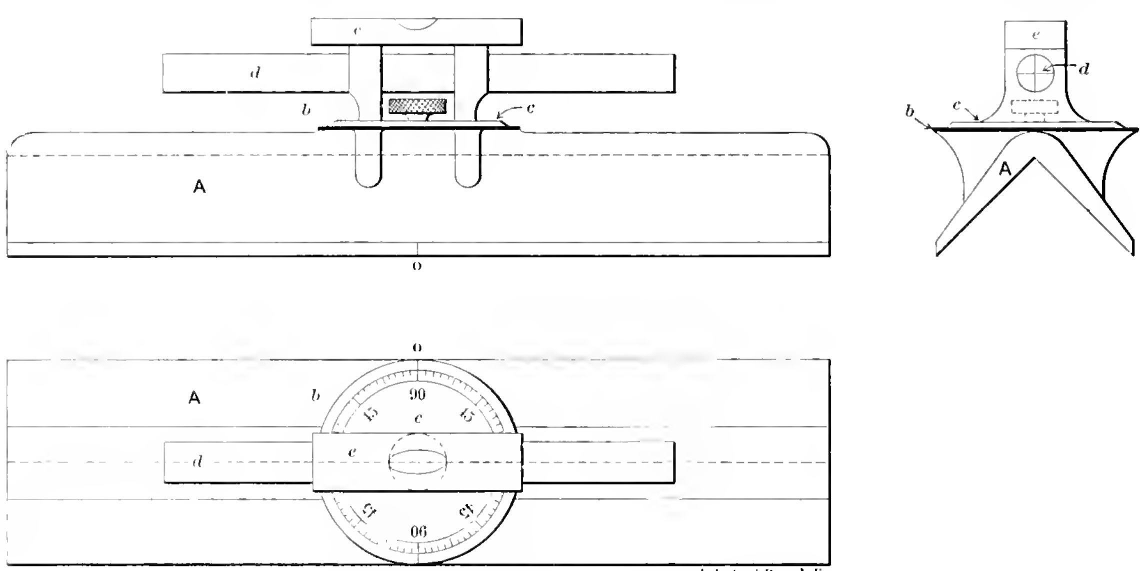


Fig. 1. Leveling Instrument for Aligning Shafting and Machinery.

telescope, and capable of revolution with it about the axis of the dial, completes the tool. A suitable locking device is of necessity added to keep the dial in position. Another detail is the parallel sides of the V, permitting the use of the tool on large as well as small shafts and on which a line o is struck, to correspond with the center of the dial. The form of tool used by the owner was very simple, with poor sights and no glasses, yet a fair degree of accuracy was attained.

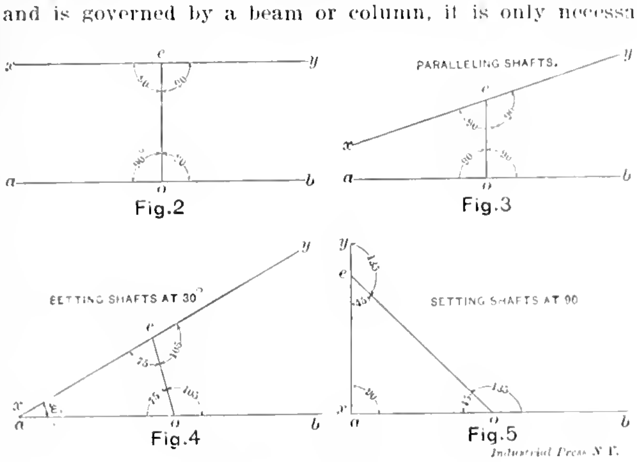
With this simple description of the tool in mind we can consider the principle of its operation, which is simpler than the tool.

In Fig. 2, a b is a straight line, on which at any point o erect a perpendicular, and the angles are equal or 90 degrees each. At any point e in this perpendicular line erect perpendiculars e x and e y, then the lines a b and x y are parallel. If we consider the line a b a shaft of any diameter and take a point o and apply thereto the line o on the tool, with the telescope set at 90 degrees, and sight to a point e on another shaft x y, marking points o and e plainly with a scriber or file, and then transfer the tool to the shaft x y with the o on

tool and point e on shaft coincident and the telescope still set at 90 degrees, any variation of the point o from the line of sight proves the shafts out of parallel, as illustrated in the annexed Fig. 3, much exaggerated. Other forms of the principle are shown in Figs. 4 and 5.

When starting to hang a shaft the same method is pursued as in the case of Fig. 2, the line a b becoming the engine shaft or line shaft, as the case might be, and x y the line of shafting or countershaft to be hung. In the case of short countershafts the hangers can be placed roughly and lined up after the shaft is hung. In the case of long shafts some form of tripod would be of advantage in establishing a long line of hangers or pillow blocks, and the tool again used for a final test. Figs. 2 and 3 are the keys to all these operations. If we wish to extend a short length of shafting already in position we find the location of the nearest or furthest hanger by placing the tool on the end of the shaft and sighting to a plumb line or other target, so the line for all the hangers can be found at once.

Fig. 6 shows an example of a right angle drive, the problem being to determine the position of the mule pulleys, or the driving and driven pulleys. If the position of the mule pulley stand is governed by a beam or column, it is only necessary



Illustrating Principle of Tool.

to sight from the shaft, with the telescopes at 90 degrees, to the rim of the mule pulleys, and the points o and e thus found become the centers of the driving and driven pulleys. If the position of the mule pulleys is governed by the location of the driving and driven pulleys, the location of the mule pulley center is found by adding or subtracting the mule pulley radius. Here another point is projected on the horizon. A squint tells whether a belt will clear a beam, column or other obstruction, before pulleys are ordered or placed. In Fig. 7 I repeat the examples of Fig. 5, where the shafts are at

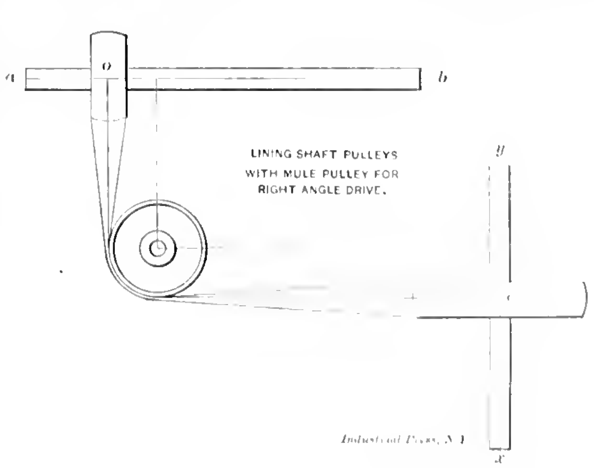


Fig. 6. Lining Shaft Pulleys with Mule Pulleys for Right Angle Drive.

90 degrees but do not intersect. The tool is placed on shaft a, b at any point o, with the telescope at 45 degrees, and the point e is found on shaft x y; the telescope is moved 90 degrees and placed over e; if the point o is in the sight line the shafts are at 90 degrees, if not, the shaft x y must be moved according to the position of o as observed from e.

Fig. 9 shows a horizontal and vertical quarter drive. In this case the height of the "sight line" above the center of the shaft must be known. To find this height place the tool on the shaft and sight to a rule, add the dimension found to the radius of the shaft and the sum gives the height above the center as per Fig. 8. To place pulleys in the case of Fig. 9 place the tool on shaft a b with the telescope at 90 degrees and note that the telescope be level, sight to the center of the shaft x y and mark both shafts; on x y the point sighted, on a b the point o on tool. To point o add the *radius* of pulley

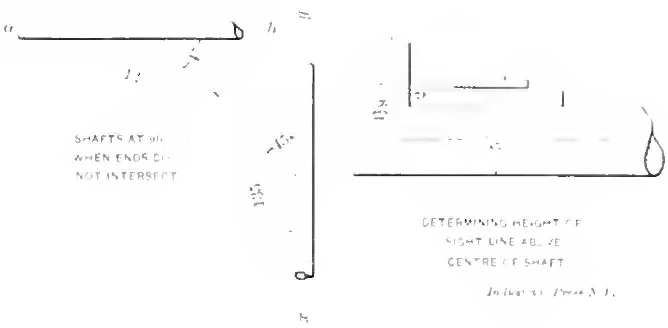


Fig 7. Fig 8.

B and to the point on shaft x y add the *difference* between the height of the "sight line" (per Fig. 8) and the *radius* of pulley A, and the points found are the centers of the driving and driven pulleys. Note that the tool is used but once, with one setting and a small possibility of error, and that the addition or subtraction is governed by the respective directions of rotation, there being four possible positions.

The addition of a cheap tripod and plumb bob dropped through the center of dial permits the use of the tool in place of an expensive engineer's transit, for a great amount of work around the mill, power-house, and in erecting machinery where few tools are available. A string of foundations can be plotted with ease and accuracy and all can be leveled from one position. From one position, such as a certain distance from the walls, the position of engines, dynamos, motors, switch boards, pipes, conduits, main, line and countershafts and machines may be determined, and hangers,

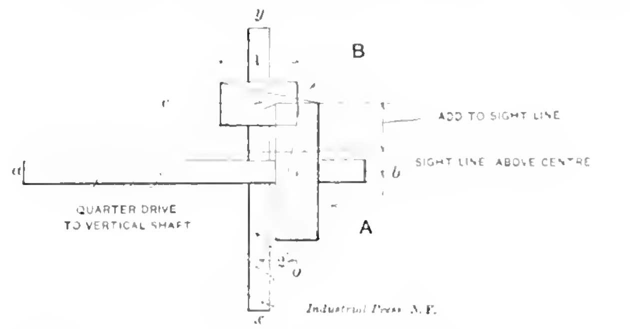


Fig. 9. Aligning Horizontal and Vertical Quarter-turn Drive.

pedestals, brackets, etc. may be placed before the shafting arrives or is finished, and the man in charge can know positively, if reasonable care be exercised, that all will be where wanted, parallel and level. Right angles and odd angles can be laid out with equal facility, and the trouble sometimes encountered by roofs being out of level, can be avoided by sighting a level line and ordering bolts and blocking accordingly. In the same way steam and exhaust pipes can be given the proper pitch for drainage without guessing and making the hangers too long or too short.

He who runs may read and profit thereby. A man may not hold a diploma to squint through a brass tube at any old thing for a target.

* * *

A Boston company, promoting a new form of rotary steam engine, designate it as "fool-proof," a legend to that effect being cast upon the casing. To make any machine foolproof is a big contract—in fact, it is one that is practically impossible. To assert the contrary in cold cast iron type is like tempting fate and is besides something of an insult to the intelligence of the operator whose share of average human nature would indeed be small if he did not some time abuse a machine so labeled.

THE GRINDING OF THREAD GAGES.*

J. R. GORDON.

I believe the best way I can answer the questions of your correspondent regarding the grinding of thread gages, is to describe the different operations I have used in making these tools. I suppose that a large proportion of the toolmakers in this country have at some time or other had the job of making gages to be used as standards of work, and that, too, without any great amount of previous experience in that line of work, and this has been my case. My first job of thread grinding occurred about eighteen years ago when I had occasion to make a tap, which, as near as I can remember, was about 1 inch in diameter, and 20 threads to the inch.

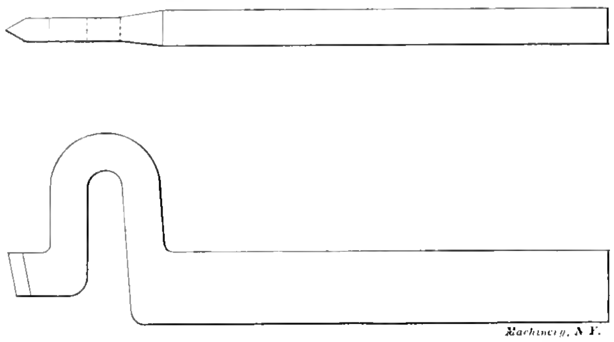


Fig. 1.

It was very important that this tap should be right, particularly regarding the pitch of thread, as it was for sizing a nut in which a measuring screw was to work. I do not remember the steel that was used in this case, but do remember that it was annealed, and was very soft and "draggy," and in order to cut the thread smoothly, it had to be taken out before the full depth of the thread was cut, and given a cold water annealing. After this was done, the thread was finished and the tap milled. It was then heated in a piece of iron pipe in the blacksmith's forge, and then dipped point first into cold water, and immediately after drawn to a light straw color. Upon examination it was found that the tap had shrunk in diameter on the end several thousandths, and the pitch had changed so that it no longer agreed with the pitch of the lathe screw.

It was decided to try grinding it, and the following method was tried. The lathe had a grinding attachment to go in the toolpost, driven by a drum on the countershaft, and in place

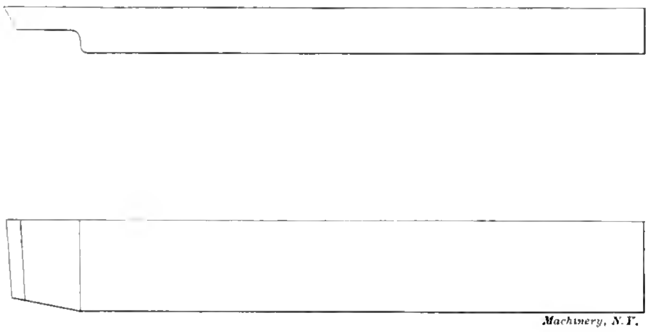


Fig. 2.

of an emery wheel we put on the spindle of the attachment a lap made of unannealed tool steel and charged with diamond dust.

Now diamond dust is by no means a common or cheap article, but it so happened that we had some left over from a job of grinding out spring chucks with very small holes, used in the same lathe in which the thread was cut, and as this was before the days of carborundum we used it for the job. The lap was charged by aid of a hardened steel bushing, acting as a roller, and it being harder than the lap the particles of the diamond were forced into the lap. When all was ready the grinding was done as follows:

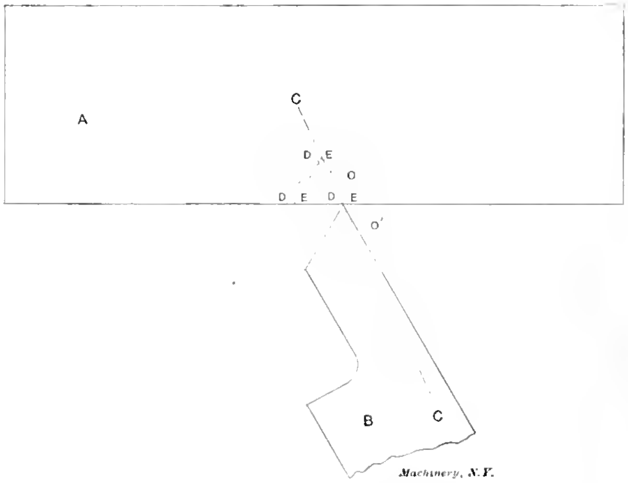
The lap was carefully set to engage in the thread of the tap, so as to have as little stock to remove as possible, and the drum started; the speed was such as to give about 6,400 revolutions per minute to the lap, which was about 1½ inches diameter. The lathe was geared as for screw cutting, the pitch, of course, being the same as the pitch of the tap. The head of the lathe was turned slowly and steadily by hand until the whole length of the thread had been traversed, when the lap was backed out, and the process repeated several times. The job came out first-rate, and the tap made a beautiful thread.

I have on one or two occasions since then used diamond dust, which may be obtained from diamond cutters generally, several of whom have shops in New York City, but I have never had occasion to grind the thread of gages, unless lapping can be called grinding. However, if your correspondent will proceed as follows he will, I think, obtain the results he is looking for. Select for the plug gage, octagon tool steel, Jessop's annealed preferred. If the diameter of the gage will permit it, drill and tap a hole for the handle, and turn and thread the gage on a nut arbor. This will not only save steel, but make it easier to harden the gage. If the lathe is not furnished with a compound rest then the threading tool should be made "goose-neck" style, as per sketch (Fig. 1). The cutting edges of the tool can not be too smooth for this work since the finer the edge the smoother the cut. The goose-neck tool will not remove stock very rapidly, so a more rigid tool should be used for roughing off the greater part of the thread.

When the lathe is furnished with a compound rest I use the following method for cutting the thread, and prefer it to any I have seen: Swivel the compound rest until the slide stands at an angle of 28 degrees from the perpendicular to the axis of the centers of the lathe. Set the tool so that its cutting sides are at the proper angle and its point the right height. Feed the tool in with the screw in the compound rest. The tool then will cut mostly on one face, the other face merely scraping off the metal on one side of the thread. The sketch (Fig. 2) shows the shape of the tool I prefer for this work. To get the proper results the thread must, when finished, be smooth, and this result will oftener be attained with steel that cuts a little brittle than with steel so soft as to drag off under the cut. The thread should next be polished, which may be done in the following manner: In place of

The accompanying diagram will probably make clear the reasons for swiveling the compound rest to 28 degrees instead of 30 degrees when cutting V threads. *A* is the piece to be threaded, *B* is the tool, *C C* is the line in which the tool is fed into the work. In the diagram the angle of this line is 25 degrees as the divergence of a line drawn at 28 degrees would be almost imperceptible in so small a drawing. *D D D* is the thread that would be cut if the compound rest was set at an angle of 30 degrees, and *E E E* is the thread that will result from feeding the tool in at 25 degrees.

It is apparent that the side of the thread marked *O* would show a series of steps, coarse or fine according to the depth of the cuts, when the tool is fed in at 30 degrees angle, whereas by feeding in at 28 degrees the side of the tool *O O* will scrape away a little metal each cut. It is of course understood that the point of the tool is set to 30 degrees to give the proper angles to the thread. Setting the compound rest at a less angle than 28 degrees will give more work for the side of the tool *O′* to perform, and consequently more work for the point of the tool, which is to be avoided as much as possible. The



result as to the shape of the thread would be the same in any case when the compound rest is set at any angle less than 30 degrees. If set at an angle greater than 30 degrees the shape of the thread would not be right.

* This article was written at our request, in reply to a question from a contributor.

the tool in the tool post put in a piece of cast-iron about the size and shape of a lathe tool and using a boring bar in the lathe, bore on the end of the piece, the arc of a circle, equal to the diameter of the gage at the bottom of the thread. Next thread this cast-iron piece the same as a chaser on the end by putting a threading tool in the bar in place of the boring tool, and, keeping the setting as it is, put the gage between the centers and using the cast-iron piece as a lap, polish the thread by chasing it over with the screw-feed. The lap should be very lightly charged with emery or carborundum and moistened with benzine to distribute the abrasive evenly.

To harden the gage procure an iron pot, such as is used to melt solder in and of sufficient size to leave room all around the largest gage to be hardened. This pot should be filled with cyanide of potassium, which should be heated until the proper color is attained. Wire the gage with wrought iron-wire, using care not to injure the thread and leaving ends to which the tongs may be applied. Place the gage in the pot and leavo it there until the proper degree of heat is attained. This will be found to be somewhat deceptive at first, and the color will be lower than it appears in the pot, to those who have never used this method before. When properly heated remove and plunge in cold water; if the gage is of one piece put the handle end first, dipping it in moderately fast, and when cold draw immediately. If the gage is made with the handle separate it should be plunged into the water edgewise. The gage will be found to be bright and clean and to have a very hard shell.

Now return it to the lathe, and using the same lap polish the thread again. Unless the gage has sprung to an unusual degree the lap will quickly polish all parts of the thread. The object of heating in the cyanide is to give a perfectly even heat to prevent springing, and the reason for using octagon steel is the same, it being more evenly rolled in the mill.

When putting the gage in cold water from the pot of cyanide the workman should use care to protect his face and person from the hot cyanide, which flies when it comes in contact with cold water.

For the ring gage the lap should be made of cast-iron, turned the right diameter and threaded, after which it is sawed through the middle, leaving both ends solid. Provision for expanding the lap may be made by a screw whose head comes below the bottom of the thread; or, if the gage is small, by drilling a hole in the end deep enough to reach about half the length of the lap and driving a wedge in to expand it. I have seen threads of ring gages that were made by a hob tap and they were very nicely made, but if the tap "goes" in hardening it is as much work to correct the tap as it is to make the gage originally, so I prefer cutting the thread in the lathe, especially if the gage is split.

Some may prefer to use animal charcoal for heating the work in; in any case, the work should be kept from the flame and air as much as possible.

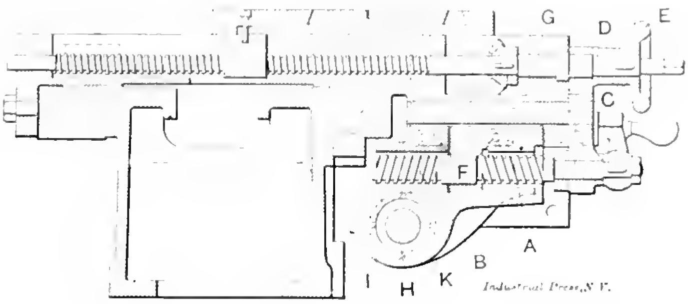
* * *

GERMAN LATHE CARRIAGE FOR SCREW CUTTING.

ROBERT GRIMSHAW.

The mechanical arrangement here shown is intended to simplify the transmission in thread cutting, the opening of the two parts of the nut being employed to withdraw the lathe tool so that only one motion of the hand is necessary. Above the two parts of the split nut, *I K*, which lie under the carriage ways and are opened and closed by a screw with a double right and left hand thread, *A* and *B*, there is an L-shaped slide having the same direction of motion, and this surrounds a shoulder on the upper part of the split nut and slides on the latter. In the front part of this slide, which is directed upward, the carriage spindle has a swivel bearing and is secured by the nut, *D*, and the check nut, *E*. While the spindle *G* follows all of the movements of the slide its own movement is unrestrained. Through the shoulders of the nut are bored the holes, *FF*, in which a steel bolt is accurately fitted. There are in the carriage, slots for this bolt which plays freely therein. Accordingly as the thread to be cut is external or internal, the bolt is placed in the front or the rear half of the nut and this is connected to the slide so that the latter, and with it the upper carriage, must follow, with the cutting tool, the movement of the nut.

In thread cutting the operation is as follows: As soon as the tool is at the end of the thread, the nut opens and the tool is withdrawn from the cut. The carriage is then, by means of the rack, brought back again by hand, the carriage spindle, *G*, is turned far enough for the next cut and the nut is closed. This brings the tool to exactly the depth for the second cut. The lathe runs continually in the forward direction and the tool is almost always in the cut, as the running back of the carriage takes but little time.



Section of German Screw-cutting Lathe Carriage having Automatic Retracting Device for Tool.

This arrangement enables cutting all threads with pitch of an even number. For odd pitches it is necessary to take care that at tho commencement of each new cut the leadscrew, *H*, and the driving arbor have the same relative position, and the carriage be brought to the same place, as before. This is easily managed by starting out, before commencing the thread, with the carriage against the tailstock; or if the threaded portion of the work-piece does not reach far enough, against an interposed piece of metal. The faceplate or the chuck is then turned by hand until the leadscrew nut, *I K*, can be shut without meeting with any resistance or requiring the carriage to be moved lengthwise of the lathe. This position of main arbor and leadscrew is indicated by a chalk mark on the faceplate (or the chuck, as the case may be) and the leadscrew. At each new cut the carriage is brought back to the tailstock or to the distance-piece mentioned, and the nut will close as soon as the two chalk marks appear in the positions in which they were originally made.

This arrangement of the nut saves much time over the usual way of running back the carriage by the belt, and running the tool in and out of the cut; further, the proper strike and depth of the tool are assured. Where the lathe is used for ordinary turning, the connection of the slide with the nut checks is broken by withdrawing the bolt, and the slide is connected with the carriage by putting the bolt in a hole which is bored through carriage and slide, over the slots. The carriage spindle is then connected with the carriage and the nut can be opened and closed independently of the slide, as is the case on ordinary lathes. Lathes fitted with this arrangement are built by H. Wohlenberg, Hanover, Germany.

* * *

Sir William Ramsey, the noted British chemist who recently visited the United States, spoke fully as enthusiastically of radium as a number of other noted physicists who have been quoted. Among other interesting statements, he said that the amount of pure radium existing in the radium compounds isolated by M. Curie and others, is very small indeed—a mere fraction of an ounce, in fact. He stated that radium-bromide dissolved in water, separates it into its component gases, hydrogen and oxygen, and continues to do so indefinitely in spite of all natural laws with which physicists have heretofore been acquainted. This, however, is not the only instance, by any means, in which radium seems to confound the doctrine of conservation of energy. But in this connection it is somewhat puzzling to understand the statement of Sir William that one pound of radium would evolve as much energy as the explosion of 250 tons of dynamite. While this expression is certainly impressive, it falls far short of continuous evolution of energy.

TOOL MAKING.—11.

DRILLS.

E. R. MARKHAM.

Drills used in machine shop work are of several varieties. The more common forms are the flat drill, single-lip drill, straightway drill and twist drill.

Flat Drills.—Flat drills are made with shanks of suitable form to allow them to be held in chucks or collets, as shown in Fig. 1. If intended for use in the engine lathe, for chucking, they are made as in Fig. 2. One end is centered as shown, and this rests on the tail center of the lathe. As this form of drill is seldom used to produce a hole of exact size it is customary to forge it to size and shape, finishing by grinding. If it is necessary to have the drill cut approximately exact to size, it may be forged somewhat wider than desired finish size. Both ends must be centered and the drill turned to size in the engine lathe. If the drill is to be ground to size after hardening, the projection *A*, Fig. 3, must be left on until after grinding. It is seldom considered advisable, however, to drill holes that must be exact with this form of drill, so the operation of grinding is not resorted to in many cases.

As the turning of a piece of stock of this form would have a tendency to cut the portion of the edge nearest the flat surface a trifle deeper than the balance of the edge, it might bind when cutting unless given sufficient relief. This is ordinarily accomplished by draw-filing. When the drill is ground to size the operation of draw-filing is not resorted to. The amount of relief given the edges should be small; .003 or .004 inch will be found sufficient. If given too much the tool will chatter when cutting. The shank should be a trifle smaller than the body of the drill, to prevent its touching the walls of a hole drilled deep enough for it to enter.

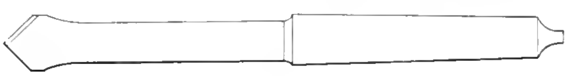


FIG. 1

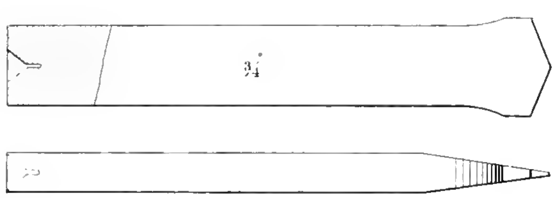


FIG. 2

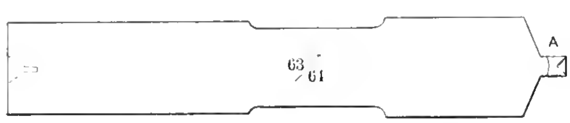


FIG. 3

Machinery, N.Y.

When a drill of this form is forged care should be exercised in heating and hammering. It should not be overheated, for this causes brittleness. The blows should be rapid and no heavier than should be given a piece of steel of the size in hand; and as the steel gets cooler the blows should be lighter to prevent a tendency to fracture the grain of the steel.

When hardening, the steel should be given as low a heat as is consistent with the steel used. The heat should extend a trifle further up than we wish the drill hardened. When dipping in the bath it should be worked up and down, to prevent a water line, and around to prevent the steam forming a cushion around the steel, which keeps the water away from the steel and prevents the operation of hardening. The water line referred to is caused by dipping a piece of red hot steel in the bath and holding it in a fixed position. This causes it to contract up to a certain point, which corresponds to the surface of the bath, and as the portion above the surface will, of course, not contract as rapidly as that below, there will result an uneven contraction each side of this given point, and the steel will either crack or break off at the surface of the bath. Working the red hot steel up and down distributes the point of unequal contraction over a greater surface and does away with the tendency to crack. These remarks apply equally well to any piece of steel which is heated for a distance greater than we wish to harden.

For use in drill press work flat drills have been almost entirely superseded by twist drills, yet at times the former are very useful. This is especially the case when an odd-sized drill is wanted, or when it is necessary to drill through the hard scale on the surface of cast iron. When drilling holes in tempered steel flat drills work much better than any other form, partly on account of their shape, and because they can be left very much harder than if a corresponding size of twist drill were used. Flat drills for drilling tempered steel will be found much harder and tougher if dipped in a bath of

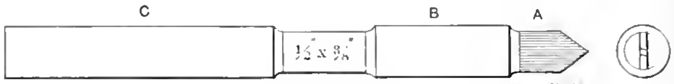


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Fig. 4.

mercury instead of water, or in the absence of mercury a block of lead may be used. Before hardening, the drill may be driven into the lead for a short distance, care being taken not to crook it by carelessness when driving. It may then be removed from the lead, heated red hot, and placed in the hole in the lead. Lead absorbs the heat in the drill rapidly enough to insure extreme hardness, and yet the action is such that extreme brittleness does not follow.

I have seen small drills, gravers, and similar tools hardened very nicely by carefully heating to a red heat and then sticking them into a potato. When drilling tempered steel use turpentine instead of oil as a lubricant.

Transfer drills are used when it is desired to transfer a smaller hole from a larger without changing the location. The portion *B*, Fig. 4, is of the size of the larger hole, while *A* is of the size of the hole to be transferred, and is a short, flat drill. The shank may be of any convenient size. After turning the various portions to size the cutting portion *A* is milled or filed to thickness. The cutting lips are then backed off and the drill hardened. The portion *B*, which runs in the hole already made, should be hard to prevent its roughing from frictional contact with the walls of the hole. The cutting portion is drawn to a straw color, while the portion *B* is left as hard as when taken from the hardening bath.

Single Lip Drill.—For certain classes of work this style of drill is very useful. As it has but one cutting edge its action

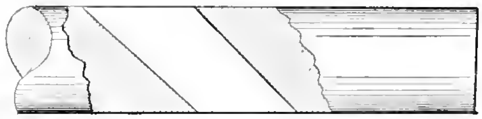


Fig. 5

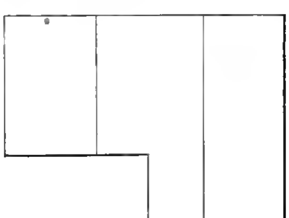
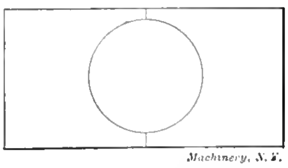


Fig. 6



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is similar to that of a boring tool used in an engine lathe for inside turning. The body of the drill being the size of the hole to be drilled there is little danger of its running, even when drilling stock containing blow-holes or where it is partly cut away. It does not cut as rapidly as other styles, and consequently is not used where a twist drill will answer; but for certain work it answers much better. When it is necessary to drill holes at an angle, through a cylindrical piece of stock, as shown in Fig. 5, this drill works better than the others, provided it is guided by a rest or bushing. It also

works nicely when drilling holes through a piece like that shown in Fig. 6, where part of the stock is cut away. In this case the drill could be guided by a bushing or the hole could be started with a twist drill and finished with the single lip.

In Fig. 7 is shown a form of single lip drill to be used with a bushing. The blank should be roughed to a size somewhat larger than finish size. The portion *C* should be turned to size and the size of the drill stamped on it, after which the shank, *B*, and the cutting end, *A*, should be finished to size, and finally the portion marked *A* may be milled as shown, so that just one-half of it remains.

If the drill must cut a hole true to size it will be necessary to make it a few thousandths of an inch large and grind it to size after it is hardened. To grind the drill it will be found necessary to face the end back, leaving the projection, *A*, containing the center, as shown in Fig. 8. After grinding, the projection may be ground away and the end of drill ground for clearance, so that it may cut. The shape to give the end is shown in Fig. 9. If single-lip drills are to be used on iron and steel and *not* on brass, they will cut more freely by making them as shown in Fig. 10. This cutting rake is given by mill-

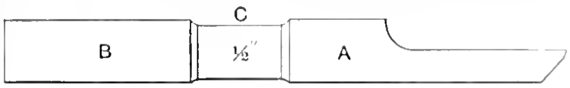

Fig. 7

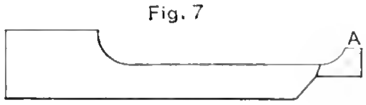

Fig. 8

Machinery, N.Y.

ing the portion *A* to the desired size, which is one-half the diameter of the blank. The end and sides of the blank are heated to a blue, or covered with the blue vitriol solution and the desired shape laid out with a scratch awl. It is then placed in the milling machine chuck on the index head, or in the vise, at the desired angle and the desired amount of rake given by milling with small end mills. The cutting lip must of course run to the center. If it is not cut as deep as the center it cannot cut; if cut deeper than one-half way it will cut, but leave a projection standing in the center of the hole. Use extreme care in heating these drills for hardening, and dip in warm water or brine to prevent springing. Many old hardeners treat drills of this form, and similar pieces of work, by dipping in the bath at an angle, as shown in Fig. 11, so as to counteract the tendency to spring from unequal contraction occasioned by unequal amount of stock at the various portions of the drill.

When single lip drills are used constantly they are made with detachable cutting blades, as shown in Fig. 12. In this case compensation can be made for wear by blocking up under the blade by means of thin sheet metal or paper. It is necessary to have the face of the blade radial. The cutter is held in position by means of two screws, as shown.

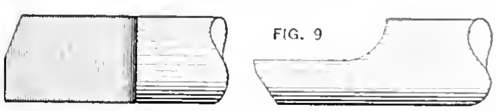
FIG. 9

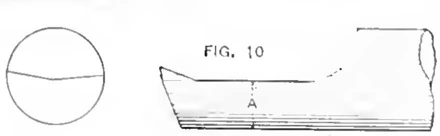

FIG. 10

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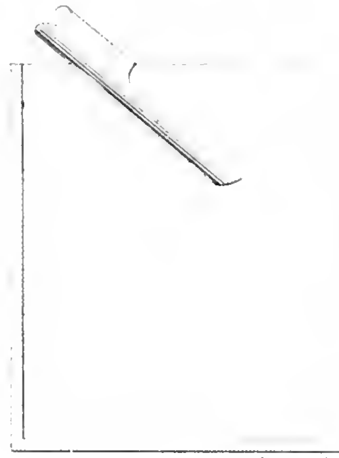
***Straightway** or **Straight Fluted Drills**.*—These differ from twist drills in that the flutes are parallel to a plane passing through the axis of the drill, as shown in Fig. 13. They are used in drilling brass and the softer metals as the tendency to draw in, peculiar to twist drills, is eliminated by the form of the flute. They are also used in drilling steel and iron when the holes break into each other, as in Fig. 16, and consequently are used when drilling for the impression in punch press blanking dies and similar work. Drills of this style, and sold in the market, have their flutes milled with a special milling cutter, although a very satisfactory drill may be produced if the flutes are made by use of an ordinary side milling cutter like that shown in Fig. 20, leaving its corner somewhat rounded to produce a round corner; this gives additional strength and reduces the tendency to crack when the drill is hardened.

Twist Drills.—In general it is not good policy to make twist drills in the ordinary machine shop; a superior article can be purchased at a cost much below that at which they are produced by machinery not especially designed for this purpose.



Machinery, N.Y.

Fig 11.

However, at times it is desirable to make a drill for a special purpose, even though the cost is greater. In an emergency the factor of cost cannot always be taken into consideration, and especially when the cost is not great enough to be considered prohibitive. When drawn wire (drill rod) of the proper size and quality can be procured, this can be used; for sizes where it is necessary to turn the stock to size it is well for the operator to use stock enough larger than finish size to enable him to remove the decarbonized portion at the surface.

For most purposes drills which are smaller than ½ inch diameter need not be ground to size after hardening; but if true holes of the size of the drill are desired it is necessary to grind them of a size larger than that above mentioned. To retain the center for use in grinding, the projection on the cutting end, Fig. 14, should be left until after the operation of grinding. After the flutes have been cut and the drill ground to desired size, the projection may be ground off and the cutting lips ground to the proper shape, as shown in Fig. 15. The smaller drills, which are made from drill rod, are cut to length, and the cutting end is given the desired angle

Diameter of Drill.	Thickness of Cutter.	Pitch in Inches.	Gear on Worm.	First Gear on Stud.	Second Gear on Stud.	Gear on Screw	Angle of Spiral.
1/16	.06	.67	24	86	24	100	16 20
1/8	.08	1.12	24	86	40	100	19 20
3/16	.11	1.67	24	64	32	72	19 25
1/4	.15	1.91	32	64	28	72	21
5/16	.19	2.92	24	64	56	72	20
3/8	.23	3.24	40	48	28	72	21
7/16	.27	3.89	56	48	24	72	20 10
1/2	.31	4.17	40	72	48	64	20 30
9/16	.35	4.86	40	64	56	72	20
5/8	.39	5.33	48	40	32	72	20 12
11/16	.44	6.12	56	40	28	64	19 30
3/4	.50	6.48	56	48	40	72	20
13/16	.56	7.29	56	48	40	64	19 20
7/8	.62	7.62	64	48	32	56	19 50
15/16	.70	8.33	48	32	40	72	19 30
1	.77	8.95	86	48	28	56	19 20

which is 59 degrees to one side of the blank. When milling the flutes use cutters which will produce grooves of the proper form. These cutters are manufactured by the Brown & Sharpe Mfg. Co., Providence, R. I. The above table and the following explanation are taken from Brown & Sharpe's book entitled "Construction and Use of Milling Machines," being intended for use with their twist drill fluting cutters. These cutters are made both right- and left-handed, and it is somewhat better to use left-handed cutters, especially for small drills, as the cut commences at the shank, thus preventing the blank lifting from the action of the cutter.

The cutter is placed on the milling machine arbor, directly over the center of the drill, and the bed of the milling machine is set at the angle of spiral as given in the table.

To obtain increased strength the depth of groove of a twist drill diminishes as it approaches the shank; otherwise the drill would break from the strain incident to cutting. The variation in depth depends on the desired strength or the use of the drill. To obtain the necessary variation of depth, the spindle of the spiral head is elevated somewhat, depending on

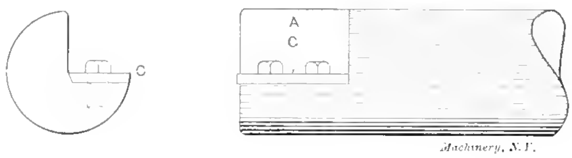
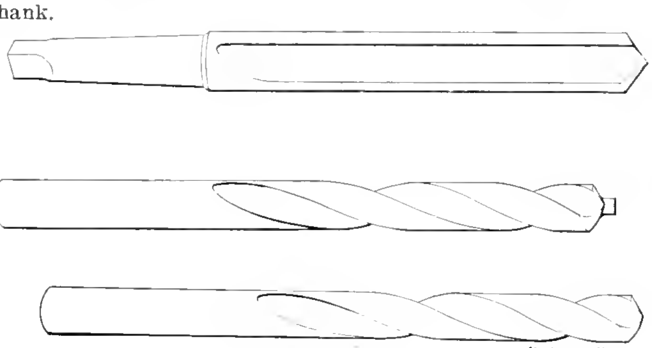


Fig. 12.

the length of the flute to be made. When less than 2 inches in length the angle should be ½ degree; for 5 inches and over in length, 1 degree. Usually this will be found satisfactory, but for extremely long drills the elevation must exceed these amounts. The outer end of the drill must be supported, as shown in Fig. 17, and when small should be held down firmly until the cutter has passed over the end. If left-handed cutters are used the pressure of the cutter holds the blank down so it is not necessary to use other means. When large drills are held by the centers the spiral head should be depressed in order to decrease the depth of groove as it approaches the shank.



Figs. 13, 14 and 15.

Another very important operation on the twist drill is that of "backing off" the rear of the lip, to give it the necessary clearance. In Fig. 18 the bed is turned to about ½ degree, as for cutting a right-hand spiral; but as the angle depends on several conditions it will be necessary to determine what the effect will be under different circumstances. A study of Fig. 18 will be sufficient for this, by assuming the effect of different angles, mills, and the pitches of spirals. The object of placing the bed at an angle is to cause the mill *E* to cut into the lip at *C* and have it just touch it at *S*. The line *R* being parallel with the face of the mill, the angular deviation of the bed is clearly shown at *A* in comparison with the side of the drill.

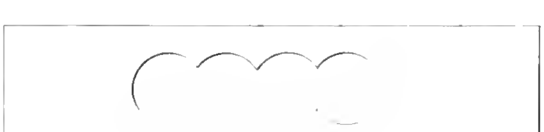


Fig. 16.

While the drill has a positive traversing and relative movement, the edge of the mill at *C* must always touch the lip a given distance from the front edge, this being the vanishing point. The other surface forming the real diameter of the drill is beyond the reach of the cutter, and is left to guide and steady it while in use. The point *C*, Fig. 18, shows where the cutting commences and its increase until it reaches a maximum depth at *C*, where it may be increased or diminished according to the angle employed in the operation. The line of cutter action is represented by *I I*.

Before "backing off," the surface of the smaller drills in particular should be oxidized by heating until it assumes some distinct color to clearly show the action of the mill on the lip of the drill, for, when satisfactory, a uniform streak of oxidized surface, from the front edge of the lip back, is left untouched by the mill, as represented at *E*.

If drills are to be ground and it is not considered advisable to center them, pointed projections of an angle of 60 degrees may be left at either end, as shown also in Fig. 18. The projections may be run in female centers in the grinding machine. After the drill has been ground to the desired size the projection on cutting end may be removed by grinding. If large holes are to be drilled deep the drills must be ground slightly tapering, making them smaller toward the shank. The amount of taper should be about .003 inch in 6 inches of length. This slight taper prevents their binding in a drilled hole, and yet is not great enough to allow the drill to run appreciably.

When hardening any tool it is, of course, necessary to conform to the facilities offered in the individual shop for doing such work; but in order to successfully harden twist drills suitable means must be provided, especially if the drills are comparatively large.

In shops where twist drills are manufactured for the market special methods of heating are provided, which insure uniform heats, and the maximum amount of work turned out. These methods are not generally understood outside the shop where they are in use, and would be of little value if they were, as it would not be feasible to install such equipment for a limited amount of work.

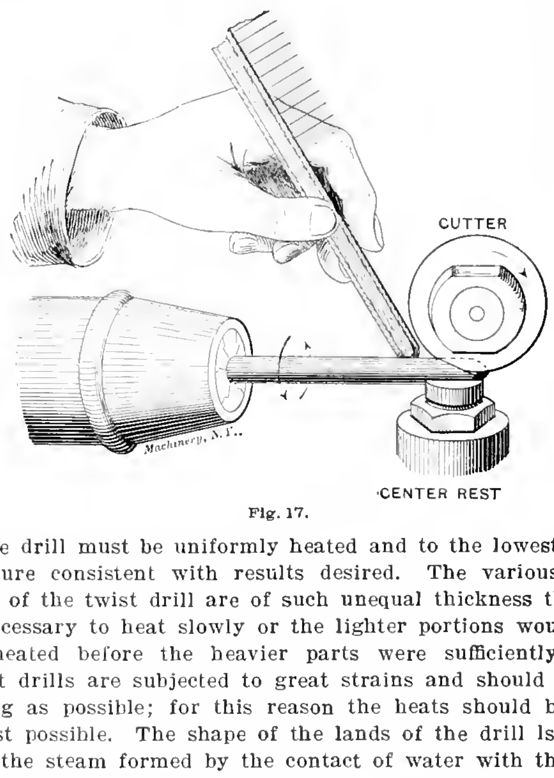


Fig. 17.

The drill must be uniformly heated and to the lowest temperature consistent with results desired. The various portions of the twist drill are of such unequal thickness that it is necessary to heat slowly or the lighter portions would be overheated before the heavier parts were sufficiently hot. Twist drills are subjected to great strains and should be as strong as possible; for this reason the heats should be the lowest possible. The shape of the lands of the drill is such that the steam formed by the contact of water with the red hot steel prevents the water from getting into the flutes and properly hardening the portion at the bottom, and as this portion forms the point of the drill, as it is ground back, it is necessary that it be hard. To overcome the tendency of the steam to force the water from the grooves a bath should be used which will insure the water reaching the bottom of the flutes. Such a bath is shown in Fig. 19. It has a jet of water coming up from the bottom, and also has perforated pipes coming up on the sides by means of which water is projected against all sides of the drill and to the bottoms of the grooves, thus insuring their hardening. This form of bath has been shown in a previous article of this series, but it is of such "all round" value, and especially when hardening articles of peculiar and irregular form, that it seems wise to again call attention to it.

The drill should be heated in a tube to prevent the fire coming in contact with the steel, unless we are using a muffle furnace, or some form where the steel is not exposed to the action of the fire or the air. A crucible of red hot lead furnishes a satisfactory means of heating drills, provided the precaution is used to prevent the lead sticking to the drill.

The following solution not only prevents the lead sticking, but as it is of a carbonaceous nature it increases, in a measure, the surface hardness:

Pulverized charred leather	1	pound
Fine family flour	1½	pounds
Fine table salt	2	pounds

The charred leather should be pulverized very fine; in fact it should be sifted through a No. 45 sieve. The three ingredients

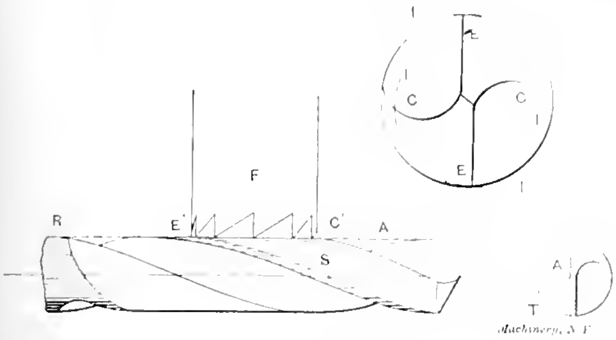


Fig. 18.

should be thoroughly mixed while in the dry state, then water should be added slowly to prevent lumps, enough water being used to bring the mixture to the consistency of varnish.

The drill may be dipped in the mixture and set in a warm place to dry, as it is never safe to immerse anything that is damp in red hot lead, the presence of moisture causing the lead to fly, endangering the eyes of the operator.

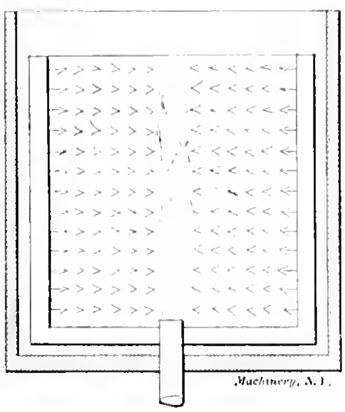


Fig. 19.

When the drill is uniformly heated it is immersed in the hardening bath and after hardening, the temper may be drawn. The amount necessary to draw the temper depends on the heat given the steel when it was hardened and the use to which the drill is to be put, although for most work a full straw color (460 degrees) is about right.

Fig. 20.

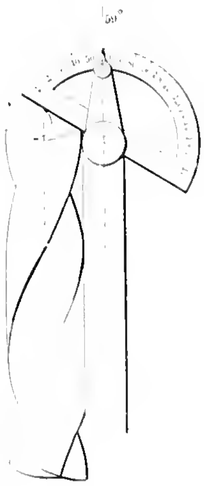


Fig. 21.

Fig. 22

Grinding Twist Drills.—The use of grinding machines designed especially for properly grinding the cutting lips of twist drills, has in a great measure done away with the extreme care necessary when grinding tools of this character by hand. Yet many shops are not provided with such machines and, as it is necessary that twist drills be properly ground, it is advisable for the young mechanic to learn to rightly grind them by hand.

Drills which are properly made have their cutting edges straight when the lips are ground to the proper angle, which, as previously stated, is 59 degrees, see Fig. 21. Grinding to an angle less than 59 degrees leaves the lip hooking, which is likely to produce an undesirable hole. An experienced operator can grind the lips of a drill to the desired angle and length, gaging the shape by the eye. The inexperienced, however, will find a gage of the form shown in Figs. 21 or 22 a great help, as by its use the correct angle and length of lip can readily be determined.

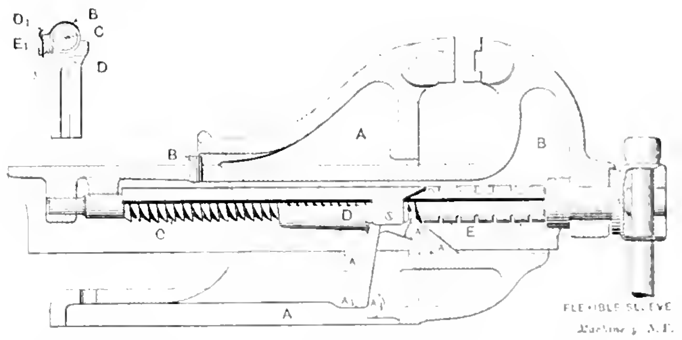
* * *

QUICK-ACTION BENCH VISE.

A large number of quick-action bench vises for machinists' use have been placed on the market, some of which have had very ingenious features. Among this number must be included a new design brought out by Charles Taylor, of Birmingham, England. For the illustration and condensed description, we are indebted to the *Mechanical World*.

A is the fixed jaw and body combined in one casting; *B* the usual sliding jaw; *C* the screw; *D* the half-nut customarily employed in this type of vise; *E* a sleeve which actuates the half-nut, replacing the usual mechanism actuated by means of a trigger, springs, etc. The half-nut *D* is engaged with or disengaged from the screw *C* automatically while rotating the screw in the act of gripping or releasing work, the movement comprising about 1/12 of a turn. Hence the whole work of gripping, releasing, engaging, and disengaging the mechanism is done by one hand in a normal movement of the lever.

In the illustration the half-nut is shown in engagement with the screw. It will be seen that immediately the gripping pressure is relaxed by turning the screw in an anti-clockwise direction, the nut, being free to do so, will fall out of engagement, leaving the jaw *B* free to slide. The work being placed between the jaws, the jaw is pushed up to the work. The lever is then rotated exactly as though the vise was a continuous screw vise. The first portion of the turn (one-twelfth of a turn) raises the nut into full mesh with



Quick-acting Bench Vise

the screw, by means of the sleeve *E*, which has a flexible grip upon the screw and turns with it until held by some positive stop (but not shown), the projection or lip E_1 (see end view) engaging the corresponding lip D_1 of the nut. While lifting, the screw and nut may make contact at the tips of the threads, and the nut be prevented from rising further by reason of the binding strain arising from the forward motion of the screw's thread, and then the tips of the thread are apt to break off. This is a point of failing in similar vises, but it is completely obviated in this vise, thus: A slight clearance is permitted in the upper way A_1 to allow the nut to fall away from the abutment A_2 by reason of its unbalanced position, and by the legs D_2 resting upon the part A_1 of the body. The angular disposition of the ways also tends to the same end, the nut advancing while rising, so minimizing the effect of the advancement of the thread while the screw is turning. This feature with a thread slightly undercut on its acting face also tends to cause a clinging together of the screw and nut, making it impossible for them to separate under blows or vibration. In the ordinary style of screw, the lever hole usually becomes bell-mouthed and reduced in diameter by an accumulation of oily grit, so tending to bind the lever. To mechanics this forms a well-known finger trap. By the removal (by drilling) of the metal at the center of the hole this sticking nuisance is obviated

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets

A movement has been started in New Haven, Conn., to erect a monument to Eli Whitney, the inventor of the cotton gin. A committee has been formed to raise a fund, and when Congress meets, a petition will be presented asking the government to make a substantial appropriation as a basis for the fund. It is proposed to erect the monument in Whitneyville, where Whitney first made his cotton gin and later established his famous factory for the manufacture of firearms.

* * *

Modern machinery applied to many industries has a tendency to shatter poetical ideals. A favorite theme has been the danger, toil and privation of the fisherman's life, and the somber pictures have by no means been overdrawn, but according to a recent report from the U. S. consul at Gothenburg, Sweden, the modern fisherman is likely to escape a great deal of the toil and danger that appeared inseparable from his lot. He says that a good many of the fishermen buy petroleum motors for their boats or cutters, some from Denmark and some from the mechanical works at Lysekil. The motors are expensive, but save so much work and delay at sea that they are still considered advantageous. The first motors used by the fishermen here were made in the United States. Boat motors are now made at several places in Sweden, however, and Denmark seems also to have gained a market there. The Northern Fisheries Exposition held in July, in the city of Marstrand, was expected to make the fishermen more familiar with the advantages of boat motors and to increase the demands for them.

* * *

FIRST AMERICAN ALTERNATING CURRENT RAILWAY.

What is expected to work a great improvement in electric railway operation and to further the transformation of steam roads to electric systems, is a new motor developed by the General Electric Company which works equally as well with either direct or alternating current. Electric railways in general are now operated with direct-current motors with voltages of 550 to 600 volts. For heavy service and extended systems the cost of copper required at this voltage becomes a serious item, and for some time there has been felt the need of a higher trolley voltage. The possible use of alternating current for the trolley would admit of a higher voltage than is possible with direct current, as the voltage could be reduced by a transformer on the car to the potential required by the motors. The development of the large power stations and transmission systems, has been principally with alternating current, requiring rotary converters or other transforming devices for changing the alternating current into direct current suitable for the operation of electric railways. Obviously there would be a great advantage in a railway-motor equipment that could be operated from an alternating-current high-voltage trolley and without the necessity of intermediate-commutating devices. Such an alternating-current equipment would offer a further advantage if it could be operated both on alternating extensions of existing systems and on the direct-current trolley where the latter is already installed.

The development of the single-phase commutator motor and its inherent fitness for traction work have created wide attention among railway interests, and work of a practical nature has been actively pushed on both sides of the Atlantic. Considerable interest therefore attaches to the operation in regular service by the Schenectady Railway Company of single-phase alternating-current motors on its Ballston extension. This is the first instance in this country, it is believed, of an alternating-current road in regular service carrying passengers, and its commercial possibilities are largely due to the fact that the motors operate with alternating-current power outside city limits and with direct-current power within the city limits. The motor as installed on the Ballston line is of the "compensated" type, so named on account of the character of the field winding, which fully neutralizes or compensates for the armature reaction. Both the compensated motors and control are adapted for operation on the 2,000-volt alternating-current trolley between cities and the standard 600-volt direct-current trolley in Schenectady. This ability of the compensated-motor equipments to run over tracks equipped with either alternating-current or direct-current trolley makes their field of application very broad, as the cars can secure all the benefit of running over existing city tracks without in any way sacrificing their running qualities upon suburban sections equipped with alternating-current trolley.

The alternating-current motor with its inherent advantages of high-voltage distribution is particularly adapted to replace the steam locomotive on either high-speed passenger or heavy-freight haulage work; and as the compensated type of motor is perfectly adapted to operate on both alternating-current and direct-current trolley, the alternating-current motor must be considered a large factor in future suburban-railway systems. The compensated motor is essentially a variable-speed motor, differing in this respect from the multiphase-induction motor, whose constant-speed characteristics proved so serious a handicap to its successful adoption in railway work. The speed-torque characteristic of the compensated motor is very similar to that of the direct-current series motor, while its commutating qualities and method of control prove equally satisfactory.

* * *

Successful photography of machine shop interiors is greatly hampered by "halation" around the window, skylight and monitor openings. That is, every opening toward the light is surrounded by a halo in the developed plate which destroys all detail for some distance from the edges. This effect is partially due to the reflection from the interior back surface of the glass plate, thus causing the fog. The so-called non-halation plates are more or less effective in cutting down the destructive effects of halation, but perhaps the best results are obtained by backing the plates with some dark non-reflecting substance. A backing that is recommended by one having experience consists of lampblack and gum-arabic mixed in the proportion of two spoonfuls of lampblack to one of gum-arabic with sufficient water to make a stiff dough. The mixture hardens into a cake and is applied to the back of the plate with a rag, and must be carefully wiped off before developing. Only a thin coating is required and it is easily removed. Backings containing glycerine are said to be bad on account of drawing moisture from the atmosphere.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The reliability and durability of the gasoline motor as applied to automobiles would seem to be pretty well demonstrated by the recent non-stop record of a Darracq touring car which made the trip from New York to St. Louis—3,400 miles—without stopping the motor during the entire run. Altogether the motor ran over fifteen days without stopping and during most of this time it was being jolted over roads, some of which are the worst in the country.

A great modern hotel like the Hotel Astor, recently completed in New York City, contains much that is of interest to the engineering profession. This hotel has a large power plant that is one of the show features of the place. It includes four Rice & Sargent tandem compound Corliss engines of 250 kilowatt capacity each, making the total power capacity nearly 1,400 horse power. This immense power capacity is required for the lighting system, operation of elevators, machinery connected with the operation of the kitchen, the ice and refrigerating system, etc.

An ingenious rifle sight called the "hyposcope" is being introduced to the notice of military authorities in Europe, which enables a soldier to sight and fire over a parapet, or other barrier, without exposing any portion of his body. The hyposcope consists of a light metallic tube made L-shape, which is clamped to the side of the barrel with the long part of the "L" vertical and the short part lying across the top of the barrel. A series of mirrors within the L-tube accurately reflect the image of the distant object in conjunction with the rifle sights to the eye, although the soldier's head may be 5 or 6 inches below the normal sighting position.

In his presidential address at the twelfth annual convention of the National Railroad Blacksmiths' Association, Mr. Lindsay referred to the fact that the secret of success is often hidden by a very thin vail, and in that connection mentioned that Professor Langley of the Smithsonian Institute, experimenting on alloy steels twenty years ago had the secret of high-speed steel within reach, but the world lost its use for fifteen years simply because he did not know how to harden it. It would have been deemed the height of foolishness then to have hardened the steel by "burning" it, but that was the secret discovered by Taylor and White, forming the basis of their famous process, which has revolutionized machine shop practice.

It doubtless has often been a matter of curiosity to many how large railway companies keep track of their locomotives. That they do keep track of them is pretty generally conceded, but there is apparently an exception if the statement of a British newspaper is to be relied on; it states that the London & Northwestern Railway has lost a locomotive. Engine sheds are being searched and every mile of the line is being examined from London to Cornwall, but no trace of the missing engine has been found. How it could have vanished the railway officials do not know; but they have two explanations to offer. One is that the engine may have been shunted on to some branch line in Cornwall or Devon, and its existence forgotten, and another that a new number may have been given to it, and the old number still retained on the company's book.

In a communication to the *American Engineer*, Mr. Edward L. Coster gives some figures showing the wonderful efficiency of heating surface of a De Glehn compound Atlantic type express locomotive on the Paris-Orleans Railway. One of these locomotives, which weighs only 80 tons, recently developed 1,900 horse power at a speed of 70 miles per hour. The total heating service of this locomotive is 2,616.8 square feet, hence it developed one indicated horse power for each 1.38 square feet of total heating service, or 0.73 indicated horse power per square foot of heating service. This would indicate that the locomotive boiler is an exceedingly efficient device for boiling water so far as heating area is concerned.

In referring to an accident that occurred in the Robinson Deep mine in South Africa a few months ago, a mining exchange cynically remarks that the hoisting rope broke at a point 350 feet from the top and the cage was precipitated to the bottom of the shaft, 2,050 feet deep, with the result that forty-three Kaffir "boys" were missing from the mine complement. A powerful writer of modern fiction has remarked that there is nothing so cheap as human life, and it would seem that the stony indifference of mine owners goes a long ways towards confirming the statement. Is there any good and valid reason why mining cages cannot be fitted with safety catches to hold them in case of the hoisting rope breaking?

The Technology Club of Syracuse was organized at Syracuse, N. Y., on January 6, 1904, with a membership of 129, including engineers, architects, analytical chemists, metallurgists and geologists. The headquarters of the club are at 707 Dillaye Building. Meetings are held monthly except during June, July, August and September. Annual election of officers is at the October meeting. Visits to manufacturing plants are one of the features of entertainment and instruction and on June last the club took a trip over the Auburn & Syracuse Electric Railway to Auburn, N. Y., and visited several large manufacturing plants and the power house of the above-named railway. Prof. John E. Sweet is president of the new organization.

A collector for the Central District and Printing Telephone Company, states the *Western Electrician*, in opening the money receptacle of the pay stations in four Allegheny, Pa., drug stores discovered a number of coins of the same design as the ordinary penny, but of weight and size of a dime. He reported the matter to the treasurer, who summoned the secret service operatives to his assistance. Examinations were made, and it was discovered that, instead of being counterfeits, the money was nothing more or less than copper cents which had been worked into the size of dimes. Chemical tests showed that the result was attained by immersing the coin in muriatic acid until it was reduced to the desired size, the operation taking about 40 seconds.

A newspaper item states that the *Governor Stanford*, No. 1, the first locomotive to cross the continent from the Pacific coast, is being placed in the Stanford Museum, where it will remain permanently as a relic. This engine was built in the early 60's and was brought from the East around Cape Horn in 1867. After the driving of the golden spike, the last act in the completion of the Central Pacific Railroad, on May 10, 1869, No. 1 was used by Gov. Stanford to draw his private train through Nevada to the scene of the exercises. The Central Pacific Company gave the engine a few years ago to Mrs. Stanford. It has been resting under a shed on the university campus, but is now being removed to the museum, where the rust is being scraped from it, the metal work polished and a new coat of paint added to make it appear as nearly as possible like it did when it was the finest type of locomotive in use.

The bandsaw has worked a considerable change in woodworking machinery, but so far its use in the machine shop is comparatively limited. It is, however, used to some extent with special blades for cutting off bar stock and similar work. A British concern, Clifton & Waddell, near Glasgow, has, however, applied the bandsaw to an interesting metal-working operation. They make a horizontal bandsaw, with a platen similar to that of a planer, which is used for trimming the uneven edges of flanged boiler plates. A flanged

tube sheet, for instance, is bolted to the platen, and the machine started up. The feed of the platen carries the tubesheet against the saw, which trims it off to a uniform height. The wheels, carrying the saw blade, are, of course, vertically adjustable so as to adapt it to all kinds of work within its range. The machine takes work 9 feet long by 6 feet wide, by 2 feet high, and weighs about 25,000 pounds.

There are three methods of sensitive governing under high heads. The first is by means of stand pipes, into which the flow of water is diverted when shut off from the wheel, relief valves being also provided. The second, which is used largely in the U. S., is to deflect the jet or stream away from the buckets, sudden changes of speed in the centrifugal governor bringing a nozzle deflecting mechanism into action. The third is a method introduced by Mr. E. F. Cassel, in which the wheel is divided along the center line of the buckets into two sections, and the centrifugal force developed in the rotation of the wheel body itself is arranged to cause the two sections to separate slightly. A portion of the water jet is thus allowed to pass between the buckets, instead of impinging directly against them, and being part of the wheel itself, the governing action is instantaneous.—*Page's Magazine.*

The use of oil for laying dust on railways and highways has been successful in a certain sense although the cost is perhaps a serious bar to the general mitigation of the dust nuisance on dusty roads. The automobilists also complain that oil is detrimental to their tires because of its well-known destructive effects on rubber. Calcium chloride has been suggested as a cheap and harmless product for laying dust, it being effective for this purpose because of its hygroscopic quality which makes it collect moisture from the atmosphere during even the driest weather. Thus if mixed with the soil of a road bed it soon makes it damp and maintains it in that condition. Although cheaper than oil it doubtless is not nearly so permanent in its effects, and after every heavy rain it would probably have to be renewed. This is one of the valuable features of petroleum, and when used in sufficient quantities it makes a roadway waterproof the same as asphalt

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The Krupp Works, Germany, according to a consular report by Consul-General Richard Guenther, employed at the time of its last published statement, 45,289 men, of whom 4,190 were officials. The average daily wages in the steel works at Essen for the past fifty years is as follows:

AVERAGE DAILY WAGES IN KRUPP CAST STEEL WORKS, 1853-1903

Year.	Daily Wage.
1853	$0.32
1860	0.49
1870	0.73
1875	0.93
1879	0.72

Year.	Daily Wage.
1890	$.85
1900	1.14
1901	1.00
1902	1.08
1903	1.09

In a paper read by President F. C. McMath at the tenth annual meeting of the Detroit Engineering Society, on the progress of railway bridge building, the author stated that the last two decades had seen great changes and improvements in the manufacture of bridges, in common with the improvements that have taken place in other lines of manufacture. Bridge shops are greatly increased in number and in capacity; where fifteen years ago no single concern had a capacity exceeding 2,000 tons of bridge work per month, there are now a number of bridge shops that far exceed this output. For example, the American Bridge Company, at Ambridge, near Pittsburg Pa., has an estimated monthly capacity of 20,000 tons of bridge work. One of the most important departments in bridge building is the drafting room, and some idea of the scale of the concern just mentioned will be gained when it is known that provision has been made in the office for upward of 500 draftsmen.

In a paper recently read by Mr. John C. Anderson before the Louisiana Engineering Society, on steel-concrete construction, the author made a special point of the firmness with which cement mortar adheres to steel. In his opinion this union is something different from mere adhesion, being more like fusion of the particles of concrete with those of the steel surfaces. The affinity is such that there is a stronger bond between the cement mortar and the steel than there is between the particles composing the mortar itself. This will be noted when concrete is cut away from a steel beam, for the chisel will cut into the beam without causing the concrete to flake off. When it breaks loose it tends to take the metal with it, there being no well defined line of cleavage, so to speak. Another valuable feature of combined steel and concrete construction is that steel and concrete have practically the same coefficient of expansion by heat, which feature is particularly valuable in the insulation of steam pipes, or in any construction where steel or iron are subject to extreme conditions of temperature.

A spirally corrugated boiler tube is a product which is being offered to American railways as a panacea for boiler troubles. The tubes are made plain at the ends for a distance of about 8 inches, and the body is corrugated in spirals of 3¾ inches pitch. These corrugations render the tube elastic, so that expansion and contraction is taken up within the tube itself without throwing severe stresses upon the tube sheets. It is claimed that a 16-foot tube was stretched ⅝ inch without giving it a permanent set. Hence it may be expected that the ordinary expansion and contraction of a tube in service will be compensated in the tube itself without disturbing its connections with the tube sheets which, as is well known, is the prime cause of most tube troubles. A serious objection to these corrugations, however, would appear to be in the corrugations collecting cinders, but it is claimed that there is no trouble experienced from this source whatever. The increased area of the tube due to the corrugations and their angular projections make such flues more efficient in the transmission of heat, it is claimed, so that there is a marked saving in fuel by their use.

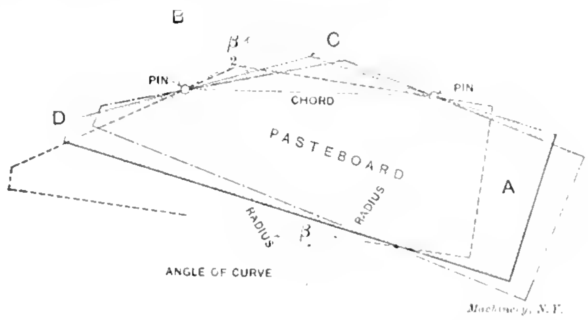
Undoubtedly when all points of advantage and disadvantage are considered the nut-lock *par excellence* for machinery is the double nut with a cotter pin through the bolt back of the second nut. There are, however, some points regarding the size and shape of the second nut that should be recognized and applied to get the best results. It should be made thin, say two-fifths the thickness of a standard nut, and should be chamfered on the bearing side so as to bear heaviest next the thread. Made in this way the lock nut wedges more firmly in the thread and the main nut has less tendency to loosen it under the influence of vibration. A nut-lock has recently been patented in England which is a further extension of these principles. The second nut is made thin and is much smaller across flats than the standard nut. Although it is difficult to understand how a patent was granted for this idea, which has undoubtedly been used time and time again, we must admit that the principle is one that has received little recognition. The smaller nut having less weight than the main nut is less affected by vibration because its frictional hold is greater in proportion to its mass. Hence a vibration which might tend to loosen the main nut only causes it to wedge more tightly against the lock nut, because this remains firmly in place.

Because of the practical impossibility of automatically weighing "run-of-mine" coal when delivered into the tenders of locomotives at coaling wharfs, there has never been a systematic accurate weighing out of fuel to locomotives on American railways, the general plan being the hap-hazard method of estimating the weight from the size of the tender and its condition previous to being filled up. Hence, scarcely any road knows exactly what a class of service is costing for fuel or how any two classes of locomotives compare in the matter of fuel economy. When it is known that coal is one of the biggest items of cost in railway operation it seems lax to

allow this condition to continue. Although run-of-mine coal cannot be accurately weighed on automatic scales such as are used for weighing grain, etc., there is no trouble in weighing in this way coal that is regular in size. This leads a correspondent in the *Railway Review* to call attention to the fact and to the obvious economy that would result in every railway providing coal crushers for reducing all locomotive fuel to an even size. All large power plants regard the coal crusher as a most necessary part of their equipment; crushed coal is easier to handle and is more economical to use since it can be spread more evenly over the grates and combustion is more nearly perfect. Smoke is reduced and the full area of the grates is more nearly utilized.

METHOD OF PLOTTING CURVE FROM AN INACCESSIBLE CENTER.

Correspondents of the *Engineering News* have revived or rather called attention to a useful method of plotting a curve of long radius when the center is inaccessible. Two pins are stuck into the drawing board at the ends of the required curve, and a piece of pasteboard A is cut so that the exterior angle $B\,C\,D$ is one-half that of the required arc. Thus, if the



angle subtended at the center is 40 degrees, angle $B\,C\,D$ would be 20 degrees. To lay off the curve the pasteboard is pressed against the pins, as shown in the sketch, the points of the curve are marked off from the vertex C. The hatched lines show the position of the pasteboard templet and the dotted lines, other positions that it occupies as the points are laid down.

DEVICE FOR PREVENTING EXPLOSIONS OF GASOLINE AND OTHER INFLAMMABLE LIQUIDS.

A consular report from United States Consul Halstead at Birmingham, England, describes an invention called "nonex" which is a device for preventing the explosion of receptacles containing highly inflammable liquids like gasoline, benzine, etc., which give off explosive gases. The consul says that the device is an application of the principle of the Humphrey Davy safety lamp used in gaseous mines, supplemented by a fusible cap or plug. "If a vessel of ordinary type containing an explosive liquid be subjected to sufficient outside heat, or if the contents be lighted at the orifice, the walls of the tank will burst by the force of the expansion. At an exhibition given by the Non-Explosive Device Company, a 20-gallon tank was partly filled with gasoline and placed upon a lighted bonfire. The fusible screw cap, made in two parts which were simply soldered together, soon blew out, the solder having melted, and the ascending vapor caught fire immediately; but no explosion followed, because the orifice of the tank formed the upper end of a tube which projected down inside the vessel to its bottom, where it was closed. To allow the oil or gas to percolate from the interior of the tank each of the metal layers of which this tube was composed had been perforated, and, while the perforations would permit the spirit to be poured out, they prevented the passage of the burning gas to the interior by absorbing its heat as the wire gauze does in the Davy lamp. While the gasoline contained in the tube burned, the flame did not extend to the liquid or accumulated vapor in the half-full tank. The flame was easily extinguished with a bundle of rags and then lighted and put out several times. A motor car tank to which the device was affixed was lighted with a match and extinguished at will. A gasoline can without the device exploded almost instantaneously when lighted."

INDIFFERENCE OF GERMAN WORKMEN TO SPORTS.

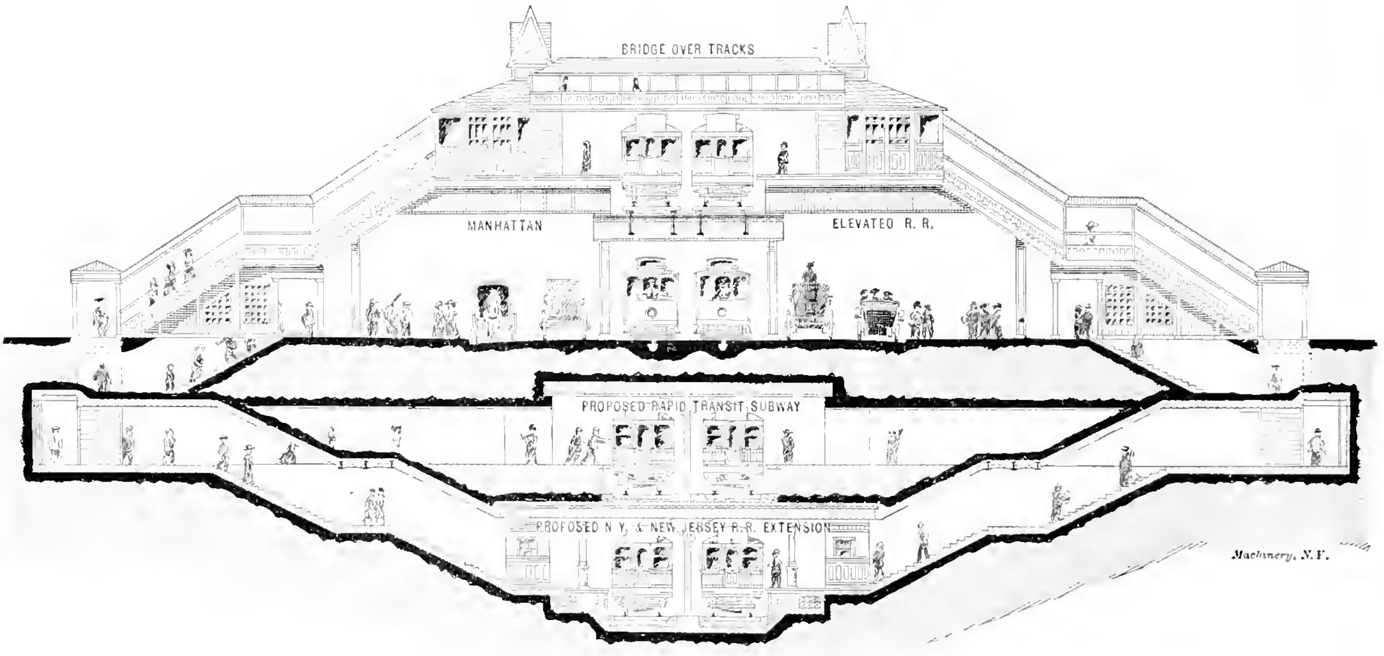
A correspondent of the London *Times*, who has written a series of reports on industrial conditions in Germany, notes a conspicuous difference in the national characteristics of the English and German workingmen as regards amusements. He says: "Amusements play a comparatively small part in the lives of German work people, and such as they have are mostly confined to Sunday. Games have not taken hold of them; they go to no football or cricket matches, although there are matches, and other classes in Germany show a growing taste for games and sports. I went to see a football match between Düsseldorf and a neighboring manufacturing town. It took place on Sunday afternoon. The day was fine and the ground very handy to both towns. A similar match anywhere in manufacturing England would have attracted from 10,000 to 20,000 sons of toil, who would have shouted themselves hoarse from beginning to end. At the German match not one put in an appearance. When I left the field toward the close of the game the spectators, who had slowly increased during the afternoon, numbered exactly 65. They were not workingmen, and they showed no excitement whatever. I noticed a curious difference in the behavior of spectators and players. In England the former keep up an almost continual noise, shouting at nearly every kick, and bursting into a prodigious roar when a good point is made; the players, on the contrary, maintain an almost unbroken silence. It was just the opposite in Germany; the spectators only raised a feeble sound when a goal was kicked, and for the rest were silent, but the players called out incessantly, directing, exhorting, and reproaching each other. They played the association game, not very well. The national game in Germany is kegel, a kind of skittles, and it is played at public houses, but not by workingmen, or seldom by them. They play cards sometimes, but not a great deal. In short, games may be ruled out as an item in industrial life."

REDUCE PRESSURE TO SAVE GAS.

It is a matter of quite general knowledge that there is a certain gas pressure at the burner tip that should not be exceeded if the most light per cubic foot of gas consumption is desired, an excess pressure means that gas is blown away and wasted. The most economical pressure, says Mr. Walter J. May in the *Practical Engineer*, is 0.3 inch water gage, or 0.25 inch if the rooms are not drafty. In the mains the pressure will be anywhere from 0.9 to 4.0 inches, which pressures will be reduced somewhat at the burner tips according to the internal condition of the service pipes. With smooth pipes the reduction is slight, but with rough pipes the loss in pressure is often large. It is a matter of substantial economy to use only pipes of fairly large capacity which are smooth internally and, in fact, cold-drawn pipes are recommended. A "wrinkle" in the economical use of gas is mentioned which is worth knowing. As everyone knows, a stop cock is placed on the supply side of the meter, and no matter whether this is fully or partially turned on, the gas in the meter is the same as on the supply side of the stop cock when the gas is not in use, but if in use the gas expands in the meter if the stop cock is turned on just enough to meet the demand at burner pressure, and this is a big loss to the consumer. To convert this loss to a gain, have a stop cock on the consumer's side of the meter, turn on the one on the supply side to its full capacity into the meter, but regulate the supply to the burners by the stop cock on the consumer's side, and take advantage of the expansion for your own benefit. In many cases this will bring down the gas bill by from 25 per cent. to 50 per cent., but attention must be paid to the regulation. As a matter of actual practice, the gas enters and fills the meter at the main pressure, say 2.0 inches; the amount required is fed into the consumer's pipes at this pressure, reducing the pressure to, say 0.3 inch at the burners, and the reduction thus obtained is obtained by the expansion of the gas in the pipes, the gain being the difference in volume in the gas—*i. e.*, the meter registers the compressed gas—which in the meter is at 2.0 inches—while the consumer uses it at the pressure most economical, and not only saves gas, but what is equally as important, gets more light by reason of the more perfect combustion.

PROPOSED FIVE LEVELS OF TRANSPORTATION IN NEW YORK.

New York, which now grows in a vertical direction because of the natural limitations of Manhattan Island, must also provide transportation facilities on more than one level in order to handle the great volume of traffic during the rush hours. In other words if the skyscraper office building shall eventually monopolize the business section, the city railways must also be built on the same plan, one above the other three and even four "stories" high. For some years the elevated and surface lines have carried the crowds in a fashion more pleasant to contemplate than to experience, and soon the subway will be opened, thus giving elevated, surface and sub-surface transportation lines traversing the city in a general north and south direction. That there will be still another level of transportation is also a possibility if the plans of the New York and New Jersey Railroad Company assume concrete shape. This is an extension or feeder of the Hudson River tunnel north from Hudson St. to the intersection of Broadway and Sixth Ave., which at that part of the route will be a sub-subway or a tunnel underneath a proposed spur of the Rapid Transit Subway. The New York *Herald* recently published an interesting diagram showing in a vertical section the four levels of railway lines at the intersection of Sixth Ave. with Broadway at Thirty-third St., and a fifth level above all in the shape of a foot-bridge over the Thirty-third St. station. This is, of course, an extreme condition, but it gives some idea of the great traffic and future plans for handling it.



Cross-section of Tracks in New York showing five Levels of Transportation.

REMEDY FOR INJURED STEEL.

La Revue Technique, July 10, 1904.

Messrs. Stead and Richards, of England, have developed an exceedingly simple process for the amelioration of steel that has been injured, burned or rendered brittle in the course of manufacture. Large masses of steel that are to be forged or rolled are heated in a reheating furnace before being subjected to these operations. It is essential that they should be raised to a certain temperature, which must not be too high, for otherwise they are apt to be burned, as it is called, and such burned metal is so modified in its characteristics that it will frequently break to pieces when passing between the rolls. It is generally recognized that, to obtain the best results, the temperature of this reheating should not be above 2,200 degrees F. Now Messrs. Stead and Richards have found that steel, which has been rendered useless by having been overheated and crystallized can not only be brought back to its original condition, but can even be improved by a treatment developed by them, which consists in heating the metal after it has cooled, to a temperature of from 1,550 degrees to 1,650 degrees F. It is of the first importance that this latter temperature should not be exceeded. Further than this, the process is perfectly efficacious in healing, if we may use the term, those steels that have become crystallized in service, and after the treatment they are better than when they left the forge in the first place. We know that the object of forging is to do away with this coarse crystalline structure, and when it is found to exist in a metal, we have, up to the present, known of no other way than re-forging to restore the fine texture. Messrs. Stead and Richards maintain that their method possesses the same advantage and, furthermore, that it materially increases the tensile strength, frequently as much as 100 per cent.

It should be noted, however, that the inventors do not make these claims for mild steel, but for the better qualities used in crankpins and similar places. G. L. F.

THE AEROPLANE AND FLYING MACHINE.

Abstract of Paper read by Major B. Baden-Powell, President of the Aeronautical Society, before the British Association.

The day is undoubtedly drawing near when we shall be utilizing the highway of the air for travel, and it is becoming an interesting question as to what form the motor-car of the skies is to take. A great number of abortive attempts to produce a practical apparatus have thrown considerable light on the prospects. During the last few years we have seen a great development in the construction of navigable balloons, and, in my humble opinion, these many attempts have only shown clearly what immense difficulties have to be contended with, and how little hope there is of our obtaining any real success in this direction. I do not wish to imply that the navigable balloon is an utter failure, and though such a machine may prove itself most useful on certain particular occasions, and for special purposes, such as military observation, even that is a long way from being a really practical conveyance, capable of going up in all weathers, and stemming such winds as it may be likely to encounter on any average day. A balloon must of necessity be of huge size, and it must, therefore, offer a great resistance to rapid propulsion. Speed, however, is everything in practical aerial navigation, since the great object is to be able to progress in a given direction without interference from the wind force. If the same propelling power were applied to some smaller form of apparatus, would it be possible for the machine to maintain itself in mid-air, and progress through it? Theory answers very decidedly, Yes, and even practice may point to many promising results. The aeroplane (using the word in its widest sense) may be defined as a plane, or nearly plane, surface propelled through the air in such a manner that the resulting pressure acts so as to support it against the action of gravity. The

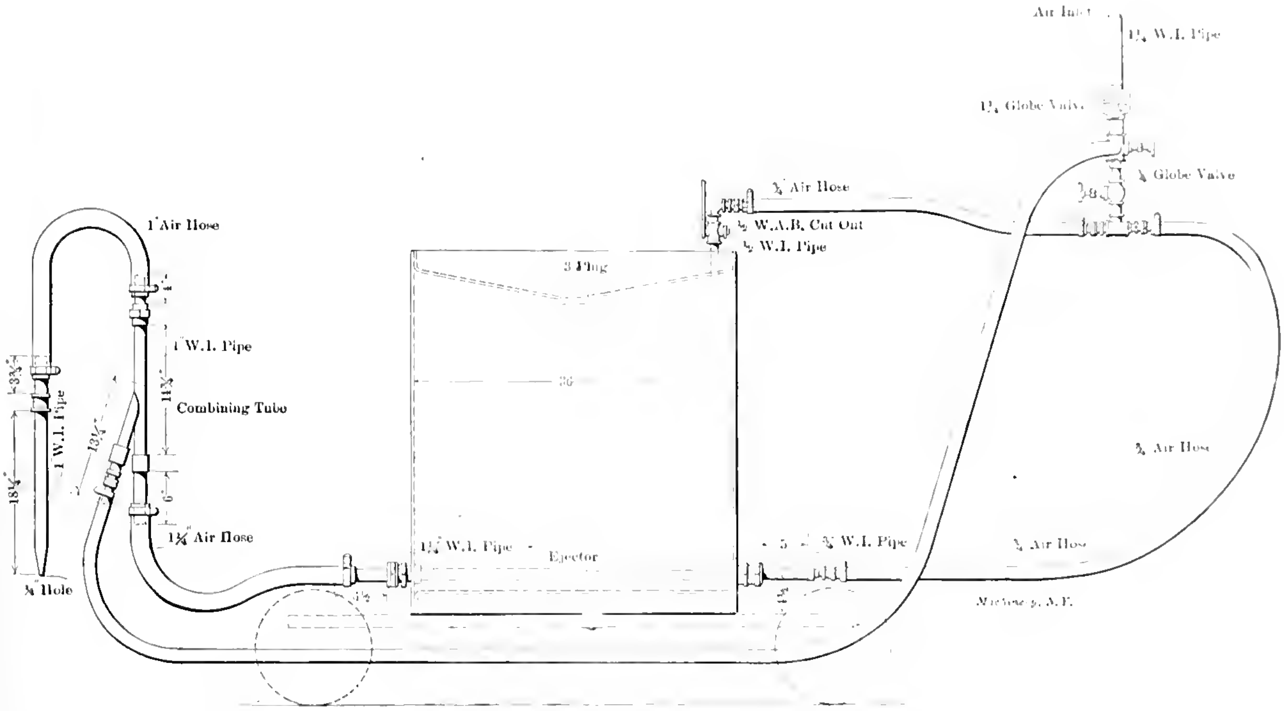
frontal resistance of such a plane, even of very large surface, seems bound to be less than that offered by a large balloon, and it should, therefore, be able to travel quicker.

Devices for attaining artificial flight may usually be classed under one of three headings—(*a*) wing action, similar to a bird's flight; (*b*) vertically-acting screws to lift the weight upwards; (*c*) aeroplanes proper, or plane surfaces propelled horizontally, with a slight upward inclination. All these three, however, are but aeroplanes according to the above definition. The wing is but the aeroplane moved up and down. The vertically-acting screw is but a pair of small aeroplanes moving round a common center. What we have, then, to study, is the action of air on inclined surfaces, and this is a subject not at all well understood. Theory and practice are much at variance. Theorists have worked out their problems, and shown what is, or should be, possible; but practice has been unable to even approximate the attainments suggested. Take the thrust of aerial screw propellers. The following are some of the records I have been able to collect:

Nadar in 1863, as the result of small experiments, computed that a thrust of 33 pounds should be got from 1 horse power. Wenham, with a spring motor calculated on 33½ pounds per

the pressure of the air acting on a plane surface moving in a normal direction—that is to say, so that the air strikes it perpendicularly, has been variously measured. All the older textbooks give the formula thus: Pressure = velocity ² .005. But the more recent experiments of Langley, Renard Dines, Stanton, and others vary from .0027 to .0039, showing a very marked and important difference from the old formula. Commandant Renard made many trials at the French Military Aeronautical Establishments. But the results, which have not been published in full, seem to have been very variable, ranging between 48 pounds and 17 pounds per horse power. He remarks, significantly, that some forms of screw are so much more efficient than others, and that there must be "a screw very much better than others, and its form cannot be much departed from without producing very bad aerial screws."

Another matter of importance on which authorities disagree is that of skin friction. Hitherto it has been supposed that the friction of the air on surfaces moving rapidly through it was negligible. Thus Langley, in his "Aerodynamics," says: "The friction of the air is inappreciable—this fact may be stated as the result both of my own experiments and of well-known experiments of others." Maxim, making his ex-



Sand Blast Apparatus for Cleaning Tenders.

horse power. Dieuiade, with a small steam engine got a pull of 26.4 pounds; and Forlanini made a little engine giving exactly the same results. Vogt, a marine engineer, made some careful comparisons between aerial and submarine screws, finding the former produced 33 pounds thrust per horse power. Later, with large screws rotated by manual power, he calculated that he got 55 pounds per horse power. Yet, when we come to trials on a large scale, we find Maxim, with his great steam engine of 360 horse power and screws of 17 feet 10 inches diameter, only gets a thrust of 2,000 pounds, or at the rate of 5.7 pounds per horse power. Santos Dumont, taking the best of aerial engines tried, obtains a pull of 175 pounds with 16 horse power, or 11 pounds per horse power. Zeppelin, with two engines of like power, only gets 220 pounds thrust, or 7 pounds per horse power. With my own little petrol motor of 1½ horse power I have only been able hitherto to get 5 pounds pull out of the screw. It is true that Walker, in his experiments with large propellers, shows from 11 pounds up to no less than 74 pounds; but these, again, may be classed as laboratory experiments. Then it has been usual for theorists to consider only the pressure of the air on the under surface of the plane. But recently a little more light has been thrown on the subject of what we may call the lack of pressure on the upper side, which undoubtedly has a considerable effect in sucking the plane upward. Even

periments with aerial screws, tested a contrivance like a screw propeller, but with perfectly flat blades, the results of which were that he found "the skin friction between the air and the polished surface is so small that it need not be taken into consideration." It might then have been considered that this point was settled. But no. Within the last few months Mr. Zahm read a paper before the Philosophical Society of Washington, giving an account of a series of careful experiments he has made, which seem to prove that the frictional resistance is at least as great for air as water in proportion to their densities. In other words, it amounts to a decided obstacle in high-speed transportation.

SAND BLAST APPARATUS FOR CLEANING TENDERS.

Railway Age, September 2, 1904, p. 303.

A method of sand blasting locomotive tenders for repainting has been in use at the Scranton shops of the Delaware, Lackawanna & Western for some time with marked success. The illustration shows the connection and form of the sand ejector, combining tube and nozzle. To bring the sand out in better quantities, air pressure is maintained within the tank. The ejector consists of two iron pipes, with open ends opposite, the blast passing from one to the other and carrying sand with it. The combining tube consists of two iron pipes welded at an acute angle, so that an unencumbered air cur-

rent at full pressure enters the sand passage and supplies additional force. The nozzle is a 1-inch iron pipe drawn down to a ¼-inch opening. The nozzle and combining tube wear rapidly but are cheaply made and easily attached.

As to results, one man can clean a 6,000-gallon tank on the trucks, as run in, in from six to ten hours, depending on its condition, quality of sand and constancy of air pressure. The latter is an item not to be overlooked, for in a shop which ordinarily works about to the limit of its air supply such a blast as this is capable of making quite an inroad. Here a good grade of lake sand is used, and it is generally used over, but after the first blasting it loses much of its sharpness and therefore requires a longer time to do the work. However, an average of about 1 square foot cleaned per minute is made. The surface obtained is ideal for painting, as it is just rough enough to hold the primer nicely.

STEAM AND ELECTRIC TRACTION COMPARED.

Railway Age, September 2, 1904, p. 290.

The impressive exhibition of power manifested by the steam locomotive with its heavy blast of smoke and sparks from the stack is quite in contrast with the electric car or locomotive, which starts and moves with so little appearance of effort. The consumption of power for obtaining the same result with trains of equal weight and speed will, of course, be nearly equal with either form of motor. The modern passenger locomotive develops 1,500 to 2,000 horsepower for a considerable period, and, in fact, this amount is often required to move trains of 600 tons at speeds called for by fast schedules. A large amount of power is required to move the locomotive itself at high speeds on account of the head-end atmospheric resistance. For this reason, only a fraction of the total tractive effort developed appears at the drawbar as useful work for hauling cars. The same is true of the electric car or locomotive, so that it may be said that the principal element of resistance at high speed is common to both kinds of traction.

As an indication of the power required to move a single electric car at even moderate speed, the following figures are given:

	Car, Length, Feet.	Weight, Pounds.	Speed, Miles per Hour.	Motor Horse Power.
Aurora, Elgin & Chicago.....	47	75,000	65	500
Columbus, London & Springfield	60	75,000	65	500
Lackawanna & Wyoming Valley	52	70,000	60	300
Rockford, Beloit & Janesville..	46	52,000	45	200

From these figures, which do not represent abnormal cases, it is apparent that from 300 to 500 horsepower is frequently placed under cars having total light weights not exceeding 75,000 pounds, this weight including, of course, the motors. Passenger trains of 600,000 pounds weight are frequently handled by locomotives weighing, engine and tender, over 300,000 pounds, and capable of producing 1,800 horsepower for short periods. This is a ratio of 1 horsepower to every 500 pounds total train and engine weight. With 500 horsepower under an electric interurban car, the ratio is about 1 horsepower to every 150 pounds per car. As all the weight can be used for adhesion and as the rotative force is uniform, the wonderful acceleration and high speed of these cars are therefore easily explained.

We have alluded to loss of power due to great air resistance at high speeds, and it is a fact that, under such conditions, this resistance being almost entirely overcome at the head end of the train, it has been deducted from the power otherwise available at the drawbar. This cannot be charged as a loss against the steam locomotive, for if the engine were absent and the power were supplied by motors the train would create the same resistance.

The operative loss due to dead weight of the locomotive, as compared with electric motor drive, is not as great as many followers of electric traction imagine. With a total engine and train weight of 900,000 pounds, about one-third may be due to the engine and tender. Upon high-power interurban electric cars the weight of the motors and controllers will amount to about one-third of the whole weight, in some cases. Therefore, so far as consumption of power used to move the motive mechanism is concerned, electricity has little advantage over steam, and but for the power consumed in hauling the fuel and water, the difference would be the other way. The great advantage, therefore, lies almost solely in the fact that the total weight of the train and its load is available for adhesion, permitting the use of enormous power. When adhesion is adequate, the steam locomotive operates under conditions far less wasteful than is conceived by many believers in the ultimate supremacy of electric traction.

The electric motor is a less delicate piece of mechanism than the locomotive; it can be worked much harder and more continuously than is possible with its predecessor, and it has, moreover, only about one-third as much internal friction. The electric locomotive is double-ended and requires no turntable. Two electric locomotives can be coupled together and operated by one engineer in the cab of the leading locomotive, each one doing its share in hauling the train. It is not necessary to consider the use of the firemen in electric propulsion, and it is on the fireman's side and not the engineer's that most of the objection to the steam locomotive arises. The disadvantages of the steam locomotive relate largely to the boiler losses and to the smoke and spark nuisance. It is standing idle a good part of the 24 hours of the day, and it is necessary to allow for coal wasted in making up and dampening the fires and the general waste incident to a locomotive when fired up but not running. It is called upon to operate at the varying temperature of the surrounding air, the coal consumption during winter months being often more than 25 per cent. in excess of that during the summer months, hence 12 to 15 per cent. additional is charged to the steam locomotive for this loss in any comparison in fuel economy with the electric power station.

* * *

The International Steam Pump Co. report the excellent performance of a Worthington pumping engine installed at the Park Avenue pumping station, Chicago. The engine is of the duplex, reciprocating, triple-expansion type, having semi-rotary steam valves, but no flywheel. The latter is replaced by compensating cylinders so arranged that their pistons retard the motion of the main piston during the first part of the stroke, but assist it towards the close, giving a uniform resultant thrust. The pistons of these auxiliary cylinders work against air under pressure from a tank. The engines are vertical and the weight of the pistons, plungers and rods is counterbalanced by another auxiliary balancing plunger, also working through the medium of water against air under pressure.

The capacity of the engine is about 22,000,000 gallons per day against a total head of slightly over 121 feet, and 660.9 horse power were indicated in the test. The duty obtained was 174,735,801 foot pounds per 1,000 pounds of steam used, corresponding to an economy of 11.32 pounds of steam per net horse power delivered in water lifted, or 10.01 pounds of steam per indicated horse power. The steam pressure was 144.45 pounds per square inch, with 154 degrees F. superheat at the throttle, the steam cylinders being provided with jackets and reheaters.

* * *

CHARTS IN DESIGNING.—2.

THICKNESS OF CYLINDERS.

JOHN S. MYERS.

Suppose it is desired to have a chart which will give the thickness of cylinders for various pressures, sizes and materials.

For thin cylinders not having a seam or joint the formula is, $t = pd/2s$, where t = thickness in inches, p = pressure in pounds per square inch, and s = allowable working stress. For thick cylinders, Burr, in his "Elasticity and Resistances of Materials," page 36, gives $t = r \left\{ \left(\frac{h+p}{h-p}\right)^{\frac{1}{2}} - 1 \right\}$; in which r = interior radius, h = maximum allowable hoop tension at

the interior of the cylinder, t and p having the same values as before. Rankine gives $R = \sqrt{(s + p/s - p)} \times r$, in which R = exterior radius, s, p and r having the same values as before. Lame gives $t = r\,(\sqrt{s + p/s - p} - 1)$. Merriman gives $t = r\,p/s - p$. Changing the notation and solving for s/p, the Burr, Rankine and Lame formulas solve out to the same form, $= s/p \dfrac{(t/r + 1)^2 + 1}{(t/r + 1)^2 - 1}$; Merriman's formula solves out to $s/p = r/t + 1$; for thin cylinders, $s/p = r/t$.

Inserting values of t/r in the Burr, Rankine and Lame formulas, the corresponding values of s/p may be calculated.

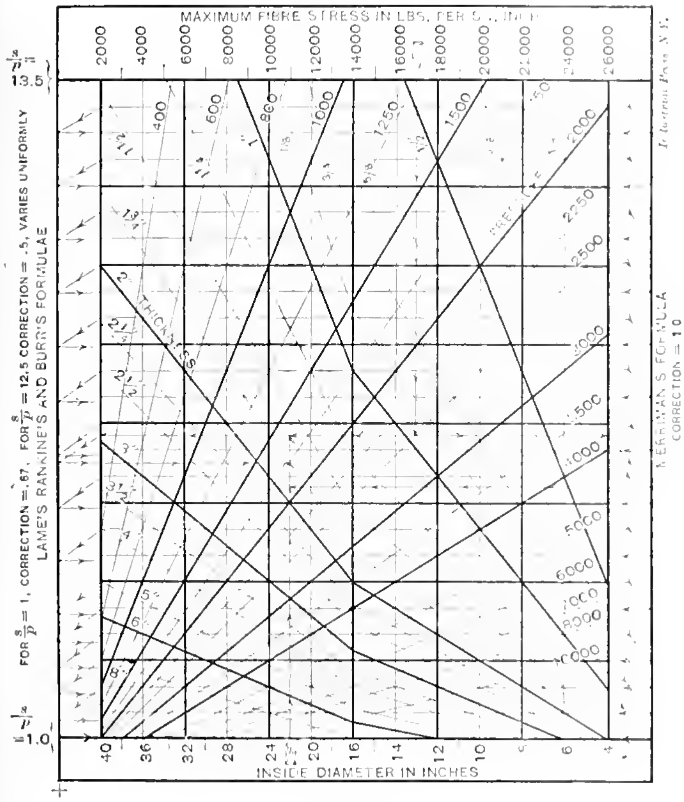


Chart No. 8. Thickness of Cylinders.

NOTATION.

Notation—d = inside diameter, r = inside rad., t = thickness of walls, S = maximum fiber stress, P = pressure per square inch. Inside cylinder, $t = \dfrac{Pr}{S}$, for thin cylinders. For thick cylinders, Rankine, Lame and Burr's formulas solve out to the same form: $t = r\left(\sqrt{\dfrac{S+P}{S-P}} - 1\right)$, or $\dfrac{S}{P} = \dfrac{\left(\dfrac{t}{r}+1\right)^2+1}{\left(\dfrac{t}{r}+1\right)^2-1}$. Merriman gives: $t = \dfrac{rP}{S-P}$, or $\dfrac{S}{P} = \dfrac{1 + t}{1}$. Example: S = 17,000; P = 2,500; d = 22". Following broken line, $t = 1\frac{5}{8}$" for thin cylinder; $t = 1\frac{3}{4}$", Rankine's formula; $t = 1\frac{7}{8}$" by Merriman's formula.

Lay out the chart for thin cylinders, choosing for the first factor at the top of the chart, s, and for the second factor $1/p$; their product, s/p, is represented by a uniform scale on the sides. See chart No. 8. The minimum reading has been chosen as 1, and the maximum reading as 13.5; each space represents 0.5. On the bottom lay off values of r, which have been chosen from 2 inches to 20 inches and doubled to read diameter instead of radius. This radius is considered a first factor commencing at the bottom of the chart, the second factor being $1/t$; their product is r/t, which is equal to s/p and is represented by the same scale at the side.

Since tracing from stress to pressure and thence to the side of chart strikes the same value as tracing from the diameter to thickness and thence to the side, they must intersect at the required thickness. The example illustrated by the broken lines is, stress = 17,000, pressure = 2,500, diameter = 22 inches; the intersection shows the thickness to be $1\frac{5}{8}$ inch, according to formula for thin cylinders. In Merriman's formula $s/p = r/t + 1$, hence a correction of 2 spaces of .5 each is made at the right side, and in the above example the intersection shows the thickness to be $1\frac{7}{8}$ inch. The corrections on the left side for Burr's, Rankine's and Lame's formulas are laid off from calculated values previously referred to. The example indicated shows the thickness according to this formula to be $1\frac{3}{4}$ inch, which is probably the most reliable as being based upon a more nearly perfect theory. It may be noticed that in calculating the corrections for Lame, Rankine and Burr's formulas the values inserted were t/r while the values of the scale on the left of the chart are r/t. This is rectified by the use of a table of reciprocals when plotting these corrections.

Steam Engine Proportions.

Chart No. 9, embodying in 24 subdivisions lettered a to x the proportions for the various parts of steam engines, illustrates how charts may be used to condense data too voluminous for ready reference, at the same time showing relations of parts in such manner that interpolation between values is facilitated. In Kent's Pocket Book will be found a rather exhaustive comparison of the Rankine, Seaton, Unwin, Thurston, Marks, Whitman and many other formulas on the subject of engine proportions, giving average results solved out for six different sizes of engines. These sizes form the basis of this series of charts. The general data of these engines is given in Table 3.

Chart a shows comparative piston speeds; chart b, indicated horsepower; chart c, mean effective pressure, the maximum pressure for all three being taken at 100 pounds per square inch. In b a change of scale has been made in order to save space; d and e show thickness of metal for cylinder and cylinder heads, respectively. It is probably the best practice to make the latter double on large sizes instead of using such thickness as shown. f and g give size and number of cylinder head studs. The curve in f is distorted at the lower end on account of inadvisability of using studs smaller than $\frac{3}{4}$ inch except on very small engines. h gives piston thickness, curve A being for the shorter and curve B for the longer stroke engines, the piston speed of which were equal for equal diameters of cylinder. i gives breadth and thickness of cylinder rings according to an empirical formula. j gives diameter of piston rods, A being for the short and B for the long stroke engines. k gives diameter of center for round connecting rods, and l and m give thickness and depths for rectangular rods, the length of rod in both cases being $2\frac{1}{2}$ times the stroke. n gives area of piston rod guides or crosshead slippers. The scale has been varied in order to save space. o and p give diameter of crankshaft for center crank engines, o being the shaft transmitting the twisting moment as well as withstanding the bending action due to thrust; while p is the shaft carrying this bending action only. q gives proportions for over-hung crank pins. $D.t.$, DB and LA, LB being respectively diameters for short and long stroke and

TABLE 3. STEAM ENGINE DATA.

		Short Stroke Engines.			Long Stroke Engines.		
Indicated horse-power	I. H. P.	50	450	1250	50	450	1250
Diameter of cylinder in inches	D	10	30	50	10	30	50
Stroke in feet	L	1	2.5	4	2	5	8
Revolutions per minute	r	250	130	90	125	65	45
Piston speed in feet per minute	S	500	650	700	500	650	700
Area of piston in square inches	a	78.54	706.86	1963.5	78.54	706.86	1963.5
Mean effective pressure	M. E. P.	42	32.3	30	42	32.3	30
Max. total unbalanced pressure	P	7854	70,686	196,350	7854	70,686	196,350
Max. total unbalanced pres. per sq. in.	p	100	100	100	100	100	100

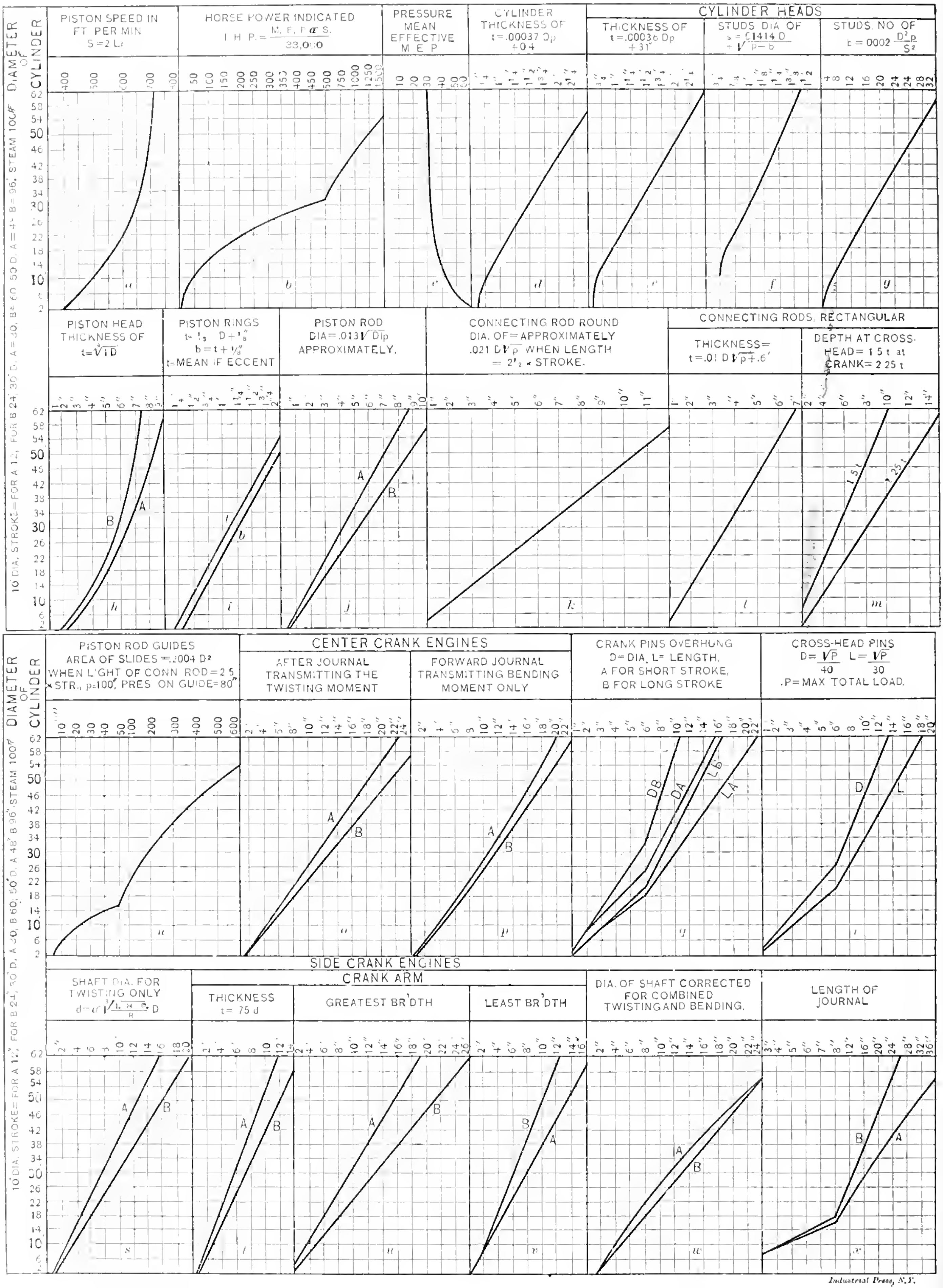


Chart No. 9. Steam Engine Proportions.

lengths for short and long stroke. *r* gives diameter *D* and length *L* of crosshead pins. *s* shows shaft diameter necessary to transmit the torsion only, which is used in proportioning the crank arm. *t*, *u* and *v* give respectively the thickness, greatest and least breadth of crank arm. It is probably a preferable construction to use a crank disk, counterbalanced. *w* gives the diameter of shaft corrected to take care of the combined twisting and bending moments. *x* gives journal length, the pressures on journal ranging from 102 to 196 pounds per square inch.

A SECTIONAL FIXTURE.

RALPH E. FLANDERS.

The casting shown in Fig. 1 strapped to the table of a milling machine is one of a large variety of housings of widely varying shapes and sizes, which are used in the construction of a certain automatic machine. These housings resemble each other in that they are provided with a V-groove at the bottom, where they are clamped to the bed of the machine, and also in the fact that they are made with various pads and bosses, similar on both sides, which have to be milled off to a uniform thickness of 1½ inches. The cross-hatching in the plan view distinguishes the finished areas.

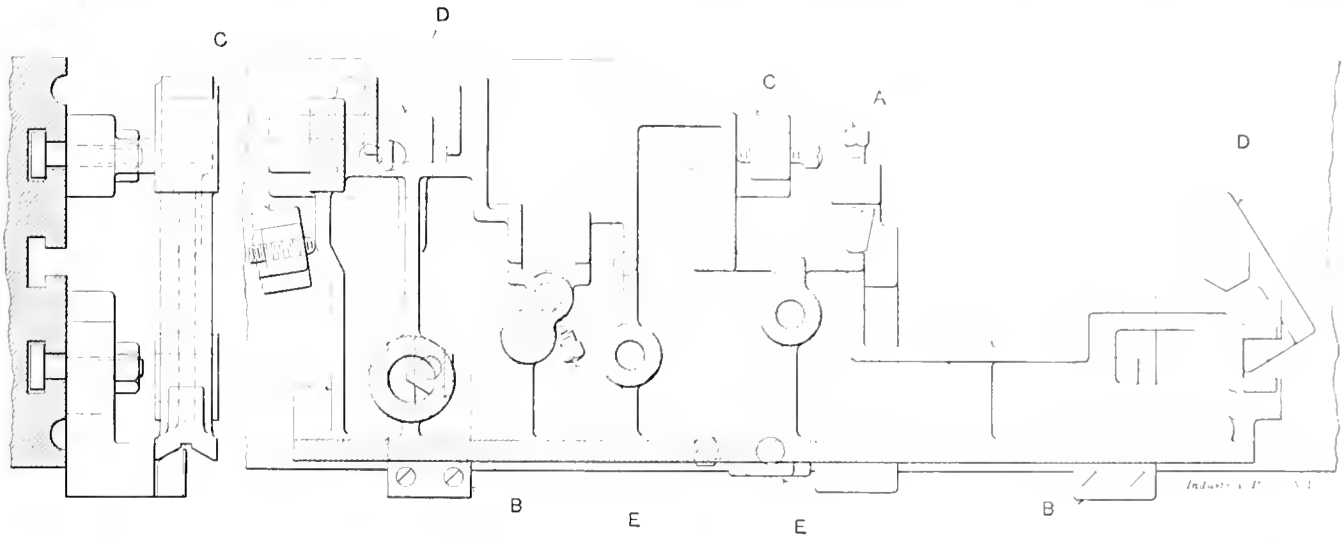


Fig. 1. A Sectional Fixture or Jig Holding a Machine Housing on a Milling Machine Platen.

The large number of patterns used would have made the job of providing a separate fixture for each style of casting a very costly proceeding. After a little thought, we made the hereinafter described sectional fixture, and it has worked well on all the different pieces on which it has been tried.

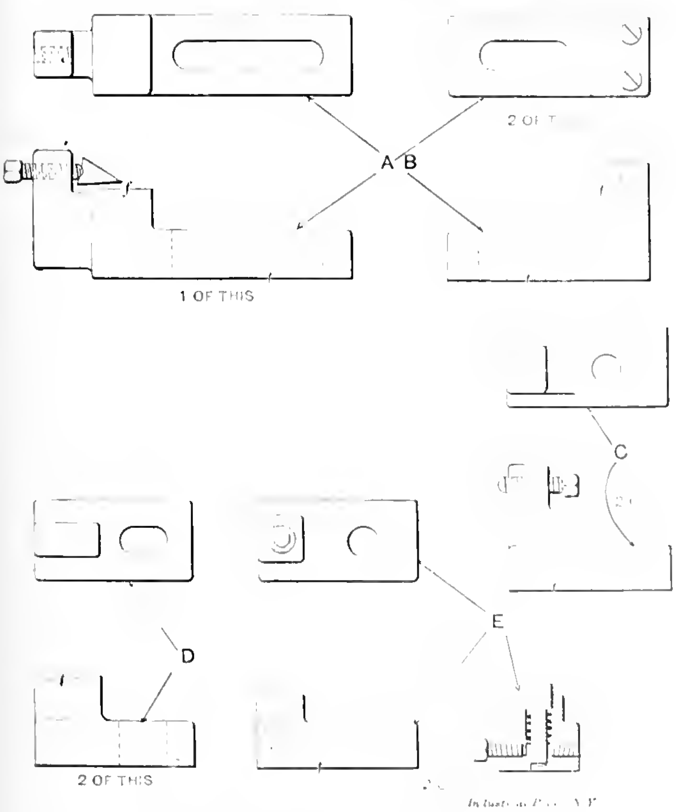


Fig. 2. Parts of the Sectional Fixture.

Fig. 2 shows the different parts of the fixture in detail: *A* is a block with a setscrew and spur, similar to that used on a planer; *B* is an abutment provided with a steel block to enter and hold down the V-groove edge of the casting; *C* is a simple stop to take the thrust of the cut; *D* is a wedge used under springy places in the casting; and *E* is a spring-jack used where convenient for a similar purpose.

In Fig. 1 a typical casting is shown on the milling machine platen with the various holding pieces arranged about it. The two blocks *B* are laid at the outside edge of the table, and the work is supported on these and the spur block *A*, thus giving a three-point bearing for a foundation. The spur holds it down on one side, and the steel blocks in the V-groove hold it down on the other. Blocks *C* with their setscrews are arranged as shown to take up the end thrust in each direction, and wedges *D* are slipped lightly into contact with outlying corners of the work where support is needed. Spring-jacks *E* are also located where the work is most liable to spring under the influence of the mill. These jacks are fastened permanently in place, the setscrews loosened, then the work is pressed down into place and fastened with the spur block *A*. The setscrew, which bears against the teat of the spring plug, is then clamped, and the casting is thus supported without the possibility of the casting being sprung as it would be if fastened down onto a solid bearing which might or might not be of the right height. The setscrew may be placed in either side, as is convenient. See detail of spring jack in Fig. 2.

A 6-inch end-mill is used in the vertical milling attachment to make the surfacing cut. This does its work more rapidly and with less pressure than a cylindrical cutter would. Care is taken to feed in such a direction that the thrust of the cut will be toward the V-blocks *B* or the stops *C*, although when by mistake the cutter was run toward the spur *A*, this seemingly insecure fastening held the work well. These housings are allowed a limit of 0.002 inch over or under the standard thickness of 1½ inch.

* * *

SOLUTION OF THE BEVEL CURVE.

CHARLES CLOUKEY.

A comprehension of the title as given above would require some knowledge of cutter heads upon which the knives or tools are bolted. These are familiar to and used mostly by woodworkers, but are the same as a milling cutter would be if the cutters were bolted to a rectangular head, with the proper extension to make the cut required. In the working of wood moldings it is often necessary to make bevel cuts of some considerable depth, and the operator is surprised to find that his knife which he has carefully ground to the proper bevel, with its cutting edge perfectly straight, does not cut the bevel with a flat surface, but with so great a convexity as to spoil the detail. By experiment he is able to grind sufficient curve on the edge of the knife to correct the error, but by a solution of the puzzle he will be able to lay out his knife properly at the start.

In the illustration is shown the plan of a cutter-head *a*, from the center of which a perpendicular, *a x*, is dropped to the bed of the machine, represented by the line *b c*. The line drawn along the side of the head in its first position intersects the vertical line at the surfacing cut, *e*, or, in other words, it is where the molding pattern begins, and all calculations are made from this intersection downward.

A careful study of the matter will show that in order to make a knife cut 1 inch deep, when bolted to a 4-inch head, it

must be projected 1 7-32 inches beyond the surfacing line, and to cut 2 inches deep the extension will be 2 5-16 inches, a gain of only 3-32 inch in the second inch of depth, and for the third inch there is little more than 1-16 inch gain, while for the fourth inch the gain is but 3-64 inch.

The trigonometrical reason for the above may be illustrated by the figure, and is contained in the statement that the line *d e* is longer in proportion to the line *o e* than the line *f i* is to the line *o i*. By using the protractor we find that the angle *d e o* is 38 deg., the tangent of which is .7813. This decimal is the ratio between the side adjacent, or *o e*, and the side opposite represented by *o d*. We find the sine of 38 deg. to be .61566, and .7813 ÷ .61566 = 1.27, which represents the hypotenuse, *d e*. Solving the triangle *f o i*, in the same manner, using the angle *f i o* of 16 deg., we find the hypotenuse or the line *f i* to be 1.04, and 1.27 — 1.04 = .23, which shows that the line *d i* is nearly ¼ inch shorter for every inch of its length, in proportion to the line *o i*, than the hypotenuse *d e* is to the line *o e*.

Now as the line *o e i* represents distance from the center of the head straight down to the bed, and the hypotenuse is the

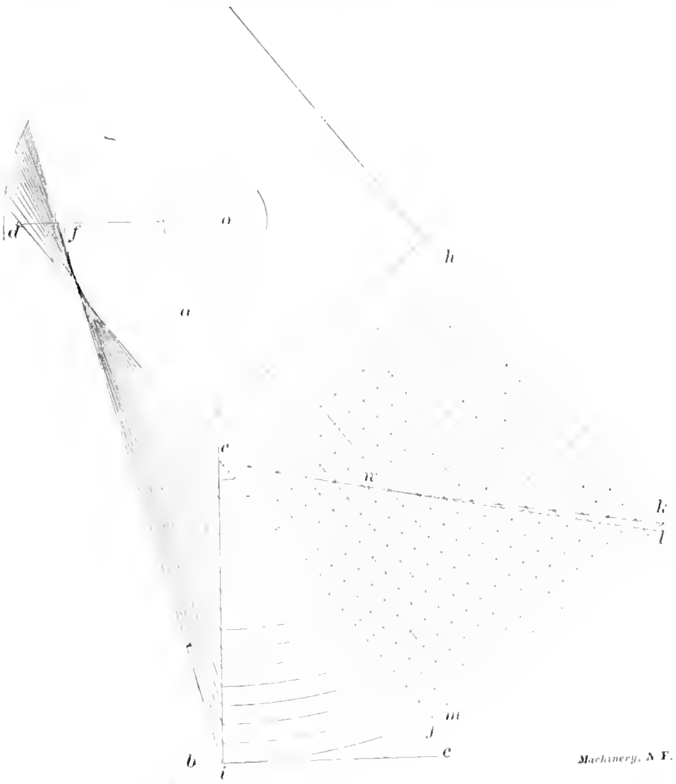


Fig. 2. Graphic Solution of the Bevel Curve.

inner line of the knife, it will be seen that to shorten the latter in relation to the former is to shorten the projection of the knife in relation to the depth of the cut. By using a full-sized drawing and a pair of accurate dividers, and measuring down the line *e j*, the first inch is found to be 11-64 inch longer than the fourth inch, so that if a knife is to be made to cut a bevel 4 inches deep the first inch will require 11-64 inch more allowance than the last, and as the variation is a gradual one it appears at once that the cutting edge of the knife cannot be straight.

Another reference to the figure will show that the knife makes its finishing cut at the vertical line *e i*, no matter what the depth, as this is the point directly under the cylinder, and that when the knife is finishing at *e* the outer end has reached *j*. This discloses the fact that the only straight line a straight knife could make across a bevel would be developed where the knife was actually cutting, and would always be ahead of the finishing line, as each cut practically begins at this line. However, the above knowledge would be of little value to the mechanic except to give him an understanding of his trouble—a diagnosis, if you please—unless a practical method is given for plotting the curve required for the edge of the knife. A still further study of the figure will show that this plot is so simple that anyone can develop it correctly, even though he is ignorant of every trigonometrical function and knows only such arithmetic as is found on his two-foot rule.

Let the point *e* represent the edge of the knife that does the surfacing, and from which point the bevel would start, and from *e* to *i*, which represents 4 inches, lay off in eighths of an inch exactly to the standard scale as found on a rule or square. The line *d e* extend indefinitely, and with *o* as a center describe the arcs from the divisions on *e i* to their intersections with the line *e j*, which gives a new and proportional scale along the line of knife extension. To develop this scale draw the lines perpendicular to *e j*, from the ends of the intersecting arcs, and extend them to the right 4 inches, or indefinitely. Along the line *e h* lay off another standard scale, the same as the one from *e* to *i*, and extend the divisions to the line *j k*. This gives a combination of the standard with the proportional scale, and by drawing the line *e k* 4 inches out and 4 inches down, through the intersections of the lines on the diagram, it will show the required curve.

If it is required to cut a sharper bevel with the same knife the practical limit is shown by the dotted lines, *n l*, on the projection. An attempt to make a vertical cut would necessitate drawing the knife back and using the 4 inches of the outer end, bringing the point *n* in coincidence with *e*. A straight line tangent to the curve at *n* and extended 4 inches diverges ⅛ inch from *k* at *l*, and transferred to *m* shows the limit beyond which the curved edge of the knife would produce a concave surface. The upper part of such a steep cut would be slightly convex for reasons already given.

The illustration and explanation so far have contemplated the use of a head 4 inches in diameter across flats, or between the faces to which the knives are bolted, and the curves for all other sizes of heads would be different, though geometrically similar. This is shown by the fact that the original of the illustration was drawn to a scale of 2 inches to 1 inch, or the same as an 8-inch head, and the printed reduction has the proper curve for the sized head that appears in the figure.

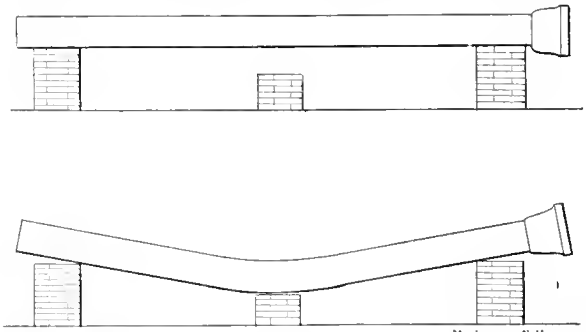
The depth of 4 inches for the cut was chosen for purposes of illustration, as in practice the cuts seldom exceed a depth of 2½ inches.

* * *

BENDING CAST IRON PIPE.

A feature of the twelfth annual meeting of the Pacific Coast Gas Association, held at San Francisco, July 19-20, 1904, was the presentation of a paper consisting of a collection of "wrinkles" contributed by practical men. Mr. T. R. Parker, Napa, Cal., sent a sketch of a method successfully followed in bending cast iron pipe. His first attempt at bending cast iron was at a lumber camp, which he relates as follows:

"Our cook could not bake bread in the stove oven on account of the cross-piece between the lids having become bent or warped so that it allowed too much cold air to pass over his



Bending Cast Iron Pipe.

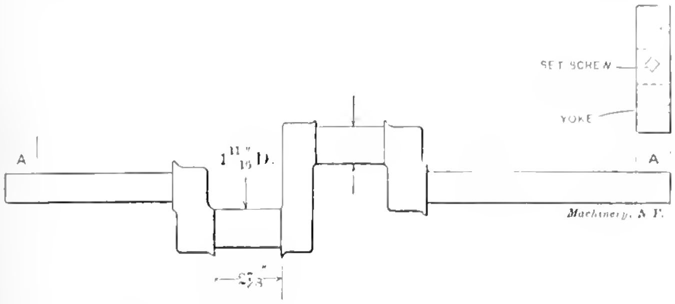
oven. He asked me if I could straighten it. I thought the same medium that bent it could unbend it, so I put it in the forge and got it to a bright cherry red, then placed it on the anvil upside down, and with a gentle pressure from the sledgehammer, brought it down straight again. So when occasion required to swing around a curve with nothing but straight lengths of cast iron pipe to do it with, I have done this, building a fire around two or more pipes, as the case might be, and letting them warp down until the center pier wall touches, then knocking out the fire and using no water to extinguish it. I have made some very pretty bends this way for the water company, withstanding 150 pounds pressure. The wood is piled after the manner that a blacksmith heats his tires."

LETTERS UPON PRACTICAL SUBJECTS.

WHAT IS THE CAUSE OF THIS TROUBLE?

Editor MACHINERY:

In the course of my work I have to turn cast steel crankshafts of the form shown in the sketch. My trouble is that I cannot get them to come round; even after taking a very light cut they will vary from 0.002 to 0.005 inch. They come small-



Why do the Cranks come "out of round" in the Center?

est in the centers of the crank-pin bearings, as indicated by the arrows. The crankshafts are held in yokes at *A A* by setscrews.

I would like to know if anyone else has such trouble, and how it can be helped. W. K.

"STANDARD" NOSE THREADS FOR LATHE SPINDLES.

Editor MACHINERY:

Over thirty years ago, as foreman of a machine shop, I was worried almost to death by the confusion in spindle threads, as chucks could not be exchanged even on lathes of the same size in many instances; so I determined that when I got to my own works that difficulty would be avoided. This was done by selecting a nose thread from each class of lathe—10 inch to 12 inch, 16 inch to 20 inch, 24 inch to 30 inch, etc.—and making gages. For example: From my first purchase of lathes, arbitrary class 16 inch to 20 inch was looked over and the best average nose thread selected for the gage. Now, some of the lathes would be larger and were, therefore, recut to it, but in those which were smaller it was necessary to put in new spindles. Each of these classes was treated in this way. Lately we have been sending these gages to the lathe builders when we order lathes. The advantages of this are too patent to need explanation, as all chucks, faceplates, etc., can be exchanged. Even in the matter of fitting new chucks the item of saving is noticeable as regards fit as well as time, since we cut the chucks to the gage and not to any lathe. Did you ever watch a good "practical machinist" fitting a new chuck back to his lathe by the old method?

Further, each lathe (excepting the smallest) has hubs or "masters" fitted with the smaller sizes of nose threads, all made to the gages. This makes the system universal, for each lathe will take all chucks of its own class, and also all chucks of smaller lathes. The sizes of these threads are not given because they are not all the sizes we would recommend. But they are practically perfect for our own work, since the advantage is primarily in the system and not in the exact diameters and pitches. We have not been so successful in changing between lathes and milling machines, as we must still make bushes and hubs to effect this class of transferring. My opinion after over forty years' experience is that all lathes and milling machines should be standard bolt threads, the length of thread to be one diameter in all cases. This would give a coarser pitch than is usual, but would be all the better for that, as chucks are less likely to seize with a coarse pitch. By this method work could be transferred, chuck and all in one piece, between lathes and milling machines. Some sizes we can now take through three machines—lathe, milling machine and gear cutter, without letting go hold. Another advantage in bolt threads is that taps can be bought in the market for sizing chuck backs. Similar remarks apply to diameter and taper of center tails. It might be well to point out that we hold all drills, reamers and facing tools in a similar manner—any lathe taking in both live and dead heads, all tools of its size and all smaller ones. The general method is that the greater includes the less.

Speaking of the existing confusion in spindle noses—lead screws and change gears are just as bad. Some time ago I asked a lathe builder in the presence of two listeners why he made a lathe for *general* use with a six-thread leading screw and the change gears in steps of four teeth, and offered a dinner for the four persons present if he would tell me. He looked a little bewildered for a short time and answered openly: "I'll be d—d if I know." This answer might be given in many instances, quite correctly, by tool builders.

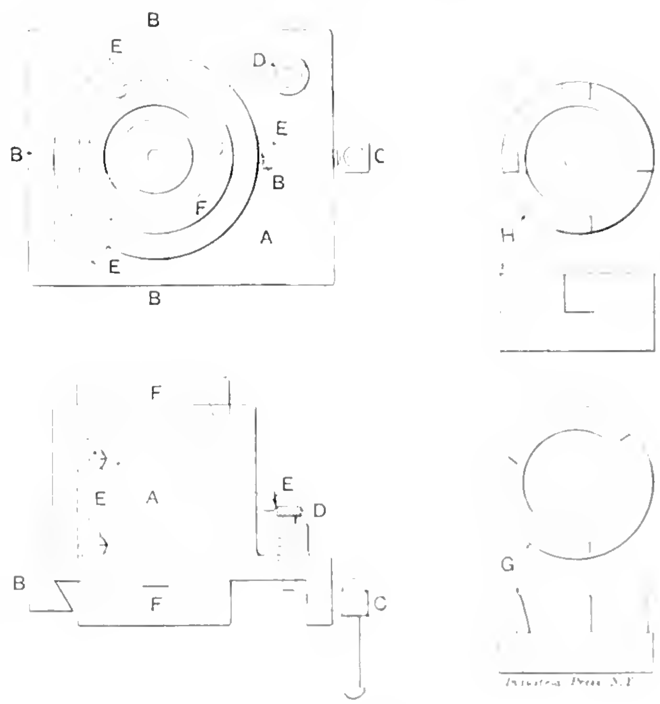
JAMES ARTHUR,
New York. President Arthur Co.

SOMETHING MORE REGARDING IDLE MACHINES—A TAPER ROUGHING REAMER—TIME-SAVING CHUCKS.

Editor MACHINERY:

In the March number of MACHINERY, I find some remarks referring to the time a machine is idle while the man is working, and I should like very much to say a few words on that subject myself.

The average workman knows a lot of ways to find something to do that requires stopping his machine, and he is inventing new ones all the time. For instance, there is a man turning down a shaft to fit a hole. He knows the shaft is one quarter inch large, but instead of starting a roughing cut he must first



Jig and Tools for Boring Pinions.

get the exact size of the hole—which he probably loses before he gets to the finishing cut—and then has to stop his lathe while he goes after it the second time. Probably the shaft in another part fits into another sized hole. If it does, this chap, unless he has an inspiration, will never think of taking a second pair of calipers and getting both measurements at once.

There are several other members in his family. There is the chap who never grinds a tool until he wants to use it, the one whose oil can is oftener empty than not, and who borrows his neighbor's because he can't stop just now; the fellow whose machine is littered up with a lot of junk, including a choice assortment of old bolts that require two wrenches to operate,

A. MERTES was born in Allegheny, Pa., February 22, 1863. He served an apprenticeship with the Pittsburg Locomotive Works, and shortly after completing his apprenticeship he started the A. Mertes Mfg. Co. (now the Union Foundry & Machine Co.) for the manufacture of gears. For the last four years he has been with the National Gear & Foundry Co. Among other positions Mr. Mertes has held that of superintendent of shops; his specialty is designing special machinery and tools.

and last, but not least, the individual who doesn't bother about how he is going to do the new job the foreman has left at his machine. Time enough to think about that when his present job is done. Besides he is not paid for thinking. He *works* for his wages.

There is a great deal of work in which the time consumed in chucking is a large item, not infrequently requiring more time than the machining, and it is in such cases that the ingenuity of the man counts. If the job becomes frequent, special facilities for handling will be provided and one of the fellows we have been talking about can do it then.

I have lately noticed an advertisement of a small plain plate provided with T slots by means of which a piece of work may be bolted to the plate and the plate secured in the machine. During the time of machining the workman can secure another blank to a second plate, and it is ready to go on the machine as soon as the first is finished, and this method of working can sometimes be used to great advantage on multiple machines.

Some years ago the writer built a machine for boring bronze spur pinions. It had six vertical spindles, three on either side, and below each set of spindles a table with an independent vertical movement. Upon these tables were placed the chucks for holding the work to be operated on. The chucks were all of the same pattern and were secured to the table in one direction by clamping against a slide and located in the other direction by a spring dowel. Being interchangeable any one of them could be used on either side of the machine and under any spindle.

Referring to the cut, *A* is the body casting which after being planed and fitted with the locking screw and spring dowel was bored on the machine by one of the spindles. The chuck was then placed central under the remaining five spindles and the holes for the dowel pin *D* located. The five holes for setscrews *E* were drilled and tapped and the four pieces of machine steel *B* fitted and fastened in place. The rings *F* shown in position were used only to center the blank and, after the setscrews were tightened, were removed. They were first made plain but as trouble was experienced on account of the blanks not being round, they were afterward cut away to give three bearing points as shown at *G*. At first they were made as shown at *H* and cut out on the thin edge to allow them to pass the four pieces *B* and the two upper setscrews.

In handling the work the first operation was roughing with the No. 1 spindles. Two castings were operated on, one on either side. While this rough boring was being done the operator chucked two other castings, using two more chucks. The first two chucks were then moved under No. 2 spindles and those just chucked went under No. 1, for roughing. The No. 3 spindles were for the finishing cut. After the finishing operation the chuck was removed from the machine and taken to a small bench where the chucking was done, the finished piece taken out and another blank chuck ready to go to No. 1. In this way the machine was running nearly all the time, yet the man had ample time to chuck the blanks and change the chucks from one position to another.

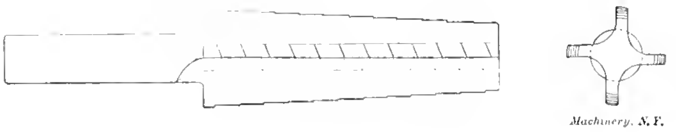


Fig. 2. Taper Reamer with Stepped Teeth.

Eventually the bronze pinions were discarded and steel forged ones used instead. This required drilling the hole from the solid. In one case, the hole, about 1 3/8 inch diameter at the smaller end had a taper of 1 1/4 inch per foot. Here was something not provided for, but by doubling the speed of No. 1 spindle, and using a one-inch drill for the initial hole, enlarging it to 1 13-16 inch on No. 2 spindle, rough reaming the taper on No. 3, and doing the finishing reaming on a drill press, it went through very nicely.

Not having had any previous experience with such a problem, I considered quite a while, and finally decided to make the roughing reamer with stepped teeth. I chased a triple thread of 1 1/2-inch lead, setting the tool so that the tops of the thread were parallel to the axis of the reamer as shown in Fig. 2, whereby the cutting was all done at the corners of the teeth. This reamer was a surprise to all who saw it in operation, it required so little power to drive it. After the roughing reaming was done the chuck was taken to a drill press which held a finishing reamer with a depth gage. The chuck was here set on a spherical seat which was mounted on a compound slide. This was done to allow the work to align itself easily, which it readily did.

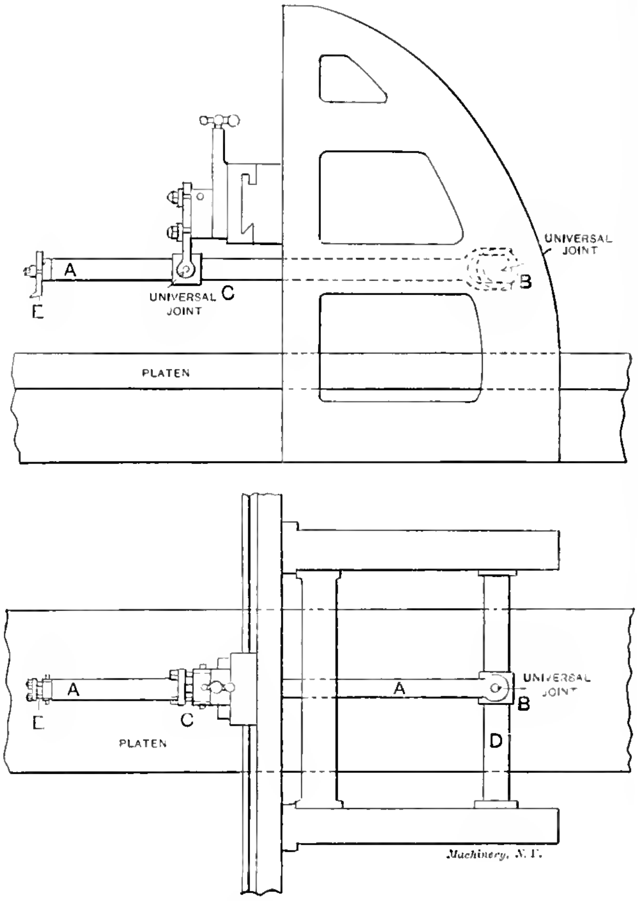
The time required to chuck a piece was about one minute and the drill passed through the blanks in from five to six minutes. The reaming required about two minutes.

Emsworth, Pa. A. MERTES.

PLANER BAR WITH STIFF SUPPORT.

Editor MACHINERY:

A troublesome job on the planer is that in which it is necessary to use an advance tool, as when planing into a cavity, taking short cuts on work wider than the housings, or cutting a keyway in a hub. The latter, of course, is a job that should not be done on the planer, but it often is done, especially on heavy work such as the hubs of large propellers, etc. When we consider the trouble and vexation caused by such jobs—nursing them to prevent the tool digging in and spoiling the work or breaking the machine—it seems strange that something better than the conventional tool with no other support than the cross-rail of the planer is not more generally used.



Planer Bar with Stiff Support.

The accompanying cut shows a side elevation and plan of a planer equipped with a planer bar or advance tool that is of old design, it having been introduced to the public some thirty or forty years ago. For some reason it seems never to have become generally known, perhaps because it was originally covered with a patent. The patent has now expired so that the public is free to use it without paying royalty. The planer bar, *A*, is forked at its rear end where it pivots on a sleeve, *B*, which is free to turn on the cross support, *D*. This latter is made of heavy section and is firmly secured to the sides of the uprights. The bar is also supported from the cross-rail by a universal joint, *C*, but this need not be of the form indicated in the cut; a ring formed from round bar stock to closely fit the planer bar and provided with a shank to clamp in the toolholder, will usually allow for the necessary vertical and transverse movements. The ring must, of course, fit the bar closely,

but if forged from a round bar it will permit considerable movement while fitting closely enough. If the bar is large enough a clapper-box can be fitted on the end for the tool, *E*. The regular feed movement is used with no change save that it is necessary to use a somewhat finer feed than usual because the movement of the tool *E* is multiplied, the factor depending upon the relative lengths of *EC* and *CB*. It will be observed that the thrust on the tool due to the cut is transmitted directly through the bar to the uprights, and that there is no twisting or canting effect upon the cross-rail whatever.

Newark, N. J. F. Emerson.

QUICK-RETURN SHAPER MOTION.

Editor Machinery:

The drawings accompanying this article represent an attempt to evolve a shaper motion in which a uniformly rotating crank gives a rectilinear motion of variable length to a shaper ram and in which it is possible to vary the length of stroke by moving an otherwise stationary point of the mechanism. The result attained seems satisfactory and has an added advantage not expected at first, that the ratio of cutting to return stroke is the same for all fractions of full stroke. As is well known the Whitworth and sliding link motion lose much of the benefit of their quick return as the stroke becomes shorter.

Figs. 1 and 2 appended illustrate the mechanism and its movements. In the two figures like elements are lettered alike. Crank *A* swings through the full circle shown by the dot-and-dash line in the direction of the arrow. Rocker *B* swings through arc *x y* on a fixed center, *k*. It is connected to crank *A* by link *C*. The relative position of the crank and rocker and their lengths are so taken that rocker *B* completes its swing from right to left in one-half the time required for its swing in the opposite direction. Bellcrank *E* rocks on pivot *G*. This point is movable and can be clamped anywhere along line *h k*. This line *h k* in the actual machine takes the form of a slot in the side of the column.

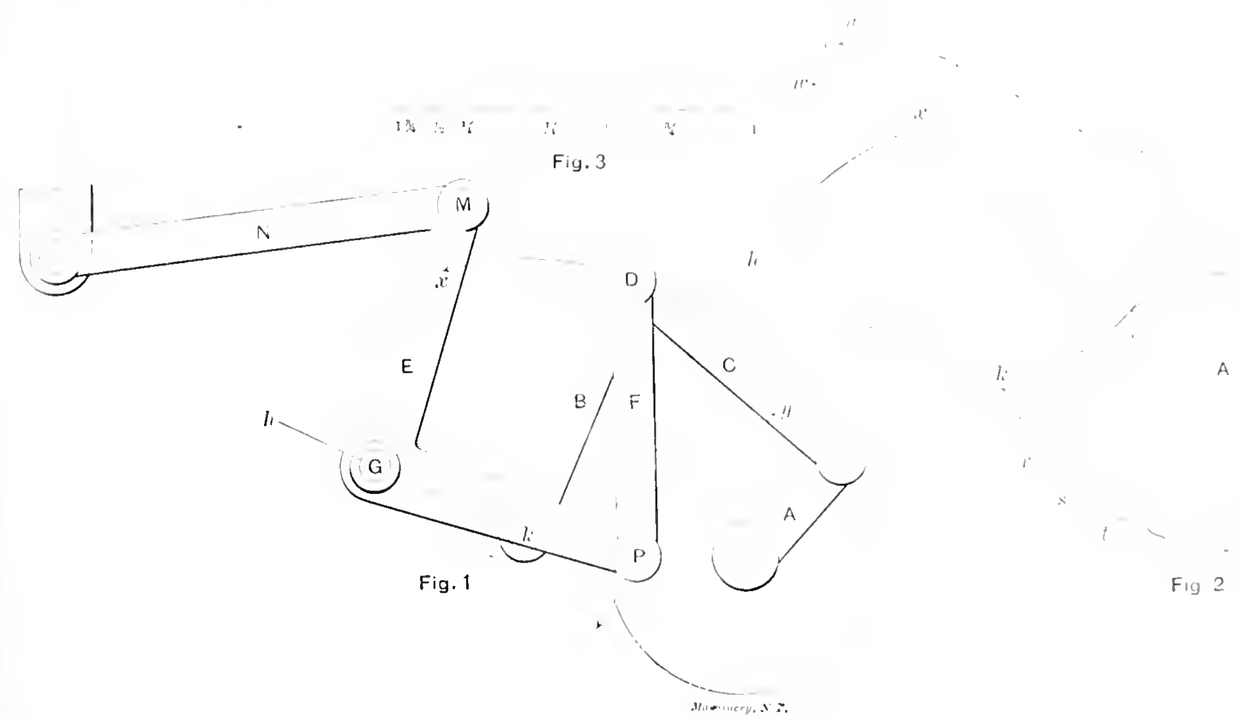
In Fig. 1 bellcrank *E* is set at half stroke. It is given motion from the end, *D*, of rocker *B*, connected to its end, *P*, by link, *F*. It will be seen that if pivot *G*, of rocker, *E*, is set at *h*, that end, *P*, will lie over *k*, and the link, *F*, will simply vibrate back and forth coincident with rocker, *B*, and the bellcrank will have no motion or will be in the position of zero stroke. If *G* is set at *k* then point *M* of the rocker will vibrate back and forth the same as the point *D* of rocker *B*, making a full stroke.

In Fig. 2 the area between the shaded arcs shows that covered by point *P* of the rocker at all positions between zero and full stroke. Arcs *r*, *s* and *t* represent the movement of point *P* for ¼, ½ and ¾ stroke respectively. At the top of the figure arcs *u*, *v* and *w* represent respectively the movement of the point *M* of the rocker for the same fractions of stroke, and on the horizontal line, Fig. 3, is shown the resulting movement of the ram. Its positions at each end of full stroke are shown by the figures 1—1, at ¾ stroke, by figures ¾, ¾, etc. It will be seen that the stroke shortens mostly at one end which, being at the back end of the stroke, we considered rather an advantage than otherwise.

The motion of rocker *B* remains the same at all times and its relative backward and forward motion is transmitted without material change through the succeeding links and cranks, so that the motion of the ram remains in the same ratio no matter how short the stroke. A ratio of 2:1 is as great as can be obtained by the mechanism shown without making the angularity of the connections too great for durability. We did not require a higher ratio but if we had we could have improved on it somewhat by substituting a Whitworth quick-return motion for the simple crank, *A*. In the actual mechanism as planned the connecting-rod *N* was turned in the opposite direction, making the mechanism more compact.

E. H. Fish

Paxton, Mass.



Quick-return Shaper Motion, giving Uniform Ratio between Cutting and Return Strokes.

THE IMPORTANCE OF LEVELING MACHINE TOOLS.

Editor Machinery:

When a man is selling lathes, and knows that they are good lathes, and then time and again has some of them roundly "cussed" because they "will not turn true," when the fact is that there is a "wind" in the bed, he soon arrives at a comprehension of the extent to which the need for correct initial setting of machines and for the preservation of this level condition is unknown or ignored. Incidentally, he studies the subject and learns considerable that before he had not even suspected to be true, and realizes the real importance of the matter.

Such is the situation with the writer, and it seems to him that the good of the trade generally and fair play for the builders of good machines, demands that the subject be given careful attention by every machine operator and owner. I speak of lathes because it is with them that I have had the most to do in this respect, and they are also probably the tools most susceptible of distortion.

At the works the parts of machines are made to fit when everything is perfectly square. If a lathe is twisted in the bed it cannot do true work. The ways, then, will not be straight and flat and the carriage in accommodating itself to their "crowns" or "dips" will give the tool point an erratic movement, and the turning will be correspondingly erratic.

Then, the tail center will be out of line, and altogether there is no telling what shape the work will take. So much for accuracy.

Possibly in these days of rapid work the question of accuracy will average up of secondary importance when compared with durability. Now, consider the increased *wear* that must result, when the ways are not straight. Then the carriage instead of bearing practically its entire length, really does so only in a few spots, and metal is rubbed off at an immensely accelerated rate. This condition will be present in a less degree at every bearing, for the strain in the bed will be communicated throughout the entire machine. The headstock will get some of it and the spindle will tend to bind in its boxes; some of the gears will not line up as nicely as they otherwise would, etc. As a consequence the tool must become worn out and decrepit long before it legitimately should.

A lathe after being run for a time while twisted will become incapable of doing accurate work, even if straightened. When under strain any metal will spring. The question is not whether it will spring but *how much* it will spring, and no matter how heavy a lathe bed may be and how well proportioned, it will "give" enough to make trouble on particular work if it does not stand just as it did when on the testing plate at the works; and because a lathe is of comparatively small size it does not follow that it will work well on three legs, so to speak.

None but a high grade level should be used. A fraction of a thousandth of an inch is the standard in fitting first-class lathes and very little "wind" in the bed will be required to cause an error of a thousandth. A "wind" of 1-16 inch in a short lathe will completely incapacitate it for fine work and yet none but a pretty good level will indicate such an error with any certainty. Surely a wooden carpenter's level will not and a short machinist's level is about as useless. A sixteen- or eighteen-inch one on the order of Starrett's No. 95 will answer very well and as the cost is only two or three dollars it would seem that the tool room of every shop should contain one. The line should split the bubble *exactly*.

The ideal location for tools is on the ground floor, of course. Vibration is bound to be present on upper floors and this and the settling of the building increases the difficulty of keeping the machines in proper shape; and in fact there are many shops whose floors are so unstable that it would be impossible to maintain a machine level in them. Yet the writer has been read the "riot act" because a lathe turned out a few thousandths under just such circumstances.

Now, give the machines and the man who sells them a "fair show." If a lathe built by a responsible concern will not do good work it is pretty safe to assume that there is or has been something wrong with the conditions, so don't insist on a new one without first investigating minutely. Have a good foundation, if possible, and if you cannot have such, do not expect too much of any lathe.

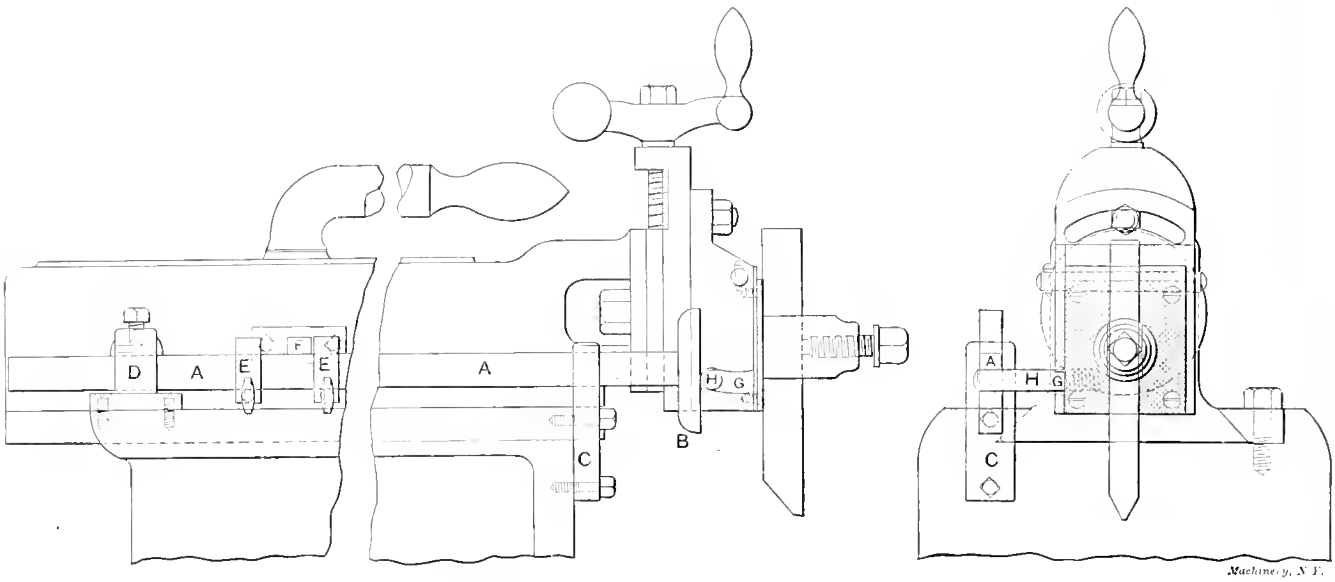
It is certainly exasperating to be forced to pocket the loss for sending a representative to look into a complaint, when nothing is wrong but this eternal leveling, and I hope that this expression may serve in a modest way to promote a better understanding between the two parties in tool deals.

"SELLEM."

DEVICE FOR PREVENTING WEAR OF SHAPER TOOLS.

Editor MACHINERY:

As our whole trade of late years is paying a great deal of attention to the small devices which save time, produce more or better work, or even make the machine operator's task easier or lighter, I will briefly describe an attachment which



Figs. 1 and 2. Side and End Views of Automatic Lifter for Shaper Tools.

we made for a Gould & Eberhardt shaper about two years ago to lift the tool during the return stroke, which I consider to be superior to anything I have seen or heard of.

Fig. 1 shows the side elevation of the shaper with the attachment connected; Fig. 2 the front end elevation, and Fig. 3 the view from the front at the section of break shown at Fig. 1. This attachment is quite simple, is easily made and is effective. *A* is a 1-inch by $1\frac{1}{2}$-inch cold-rolled steel bar with a piece welded on one end as shown at *B*. A machine steel bearing piece, shown at *C*, is attached to the front end of the shaper body and has a hole in it to allow the

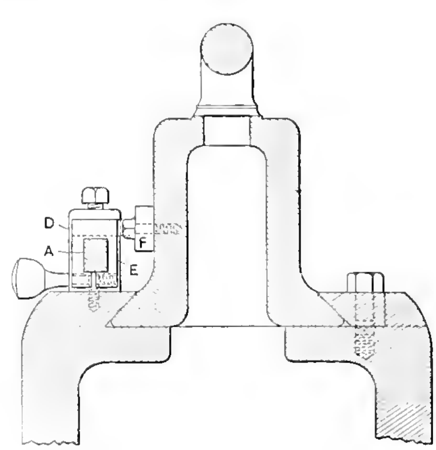


Fig. 3. Cross Section through Lifter.

bar *A* to pass through freely. The rear bearing *D* is cast gray iron and has a gib faced with leather and held down by a setscrew to produce a slight, even friction on *A*. *EE* are two machine steel blocks fitted to *A* and slotted on the under side as shown in Fig. 3. They are firmly clamped to *A* by the thumb screws. *F* is a machine steel forging bolted to the side of the shaper ram and has an arm or finger which extends over the top of *A* to engage with the blocks *EE*. For cases where it is desired to use this attachment on com-

paratively short stroke with the shaper head well forward, or back, inside the shaper body, we drilled and tapped two more sets of holes in the ram for *F*, as in such extreme cases we had to move *F* either forward or backward to accommodate the job. A slot was milled in the shaper head at *G* to allow a stud *H* which was screwed into the swinging tool block to oscillate.

The drawing Fig. 1 shows the shaper about to start on the forward stroke; during the forward stroke *F* engages with *E* and shoves the bar *A* forward, *B* being just behind *H*. As soon as the ram starts on the back stroke *F* comes back with the ram, leaving *A* and *B* until it engages with the other block *E*, when *A* is carried back with the ram. Of course, when *F* disengages with the forward block *E* at the start on the back stroke *B* comes into contact with *H* and thus raises the tool clear from work. When the back stroke is completed the bar *A* is left by *F* until the shaper ram and swinging tool block are again in the position shown. It will be noticed that the amount that the tool is raised is determined by the distance which *F* must travel between *E* and *E*, and is very easily adjusted to suit the case in hand.

We have used this attachment on a large variety of work, such as dovetailing, facing down with the vertical slide, etc., and find it gives good satisfaction, although it was originally intended only to save the tool from wear on nice finishing cuts on straight work.

A. R. Chern.

IMPROVED PLUG GAGE CONSTRUCTION.

Editor Machinery:

Having been in several large machine shops during the past two or three years, my attention was particularly attracted to the different kind of gages that were being used. First, I wish to call your attention to the fact that I am referring especially to the shops and large manufacturing plants whose articles of manufacture require exact measurements and where gages are used extensively.

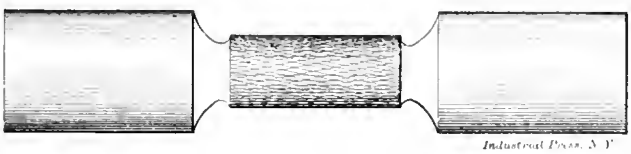


Fig. 1.

Referring to the plug and male thread gage, which I am about to discuss, the majority of these shops use the solid gage or in other words, a gage with the gage disk and handle turned from solid stock as shown in Fig. 1. This form of gage gives good satisfaction when a small gage is needed, but where one is required 1½ inch, or over, in diameter, this style becomes very heavy and awkward to handle. It has not only these drawbacks, but also others, such as requiring more high-grade material in its construction; and if the gage disk wears too much, an expensive operation has to be gone through to put it in the right shape.

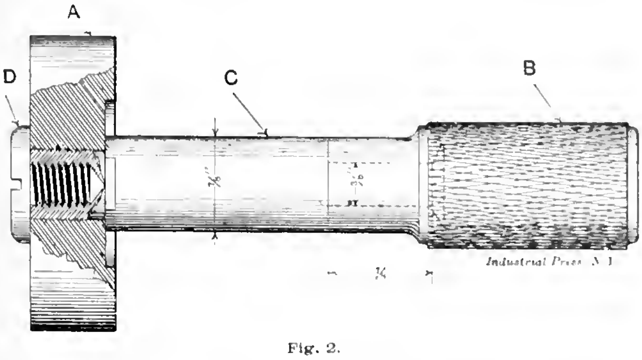


Fig. 2.

The sectional gage shown in the assembled drawing, Fig. 2, is becoming more popular each day, not only on account of its lightness, but also because of its gage disk being transferable when it becomes worn, requiring but a few seconds to make the change provided the disks are kept in stock. The handle is bored out to lighten it, and is knurled, as shown at *B*; it is turned to one or more sizes, according to the requirements of the shop, a quantity being kept in the tool room for future use. I recollect one shop in particular, which keeps four sizes of handles in stock constantly. The fastening screw, *D*, is also made in one or more standard sizes, of which a quantity is also kept in the tool room. The shank *C* is turned to size, according to length, as required.

More or less trouble has been experienced in the past in the use of the sectional gage, especially the male thread gage, on account of the fastening screw becoming loose when the gage gets stuck in the work. I remember one instance, not long ago, where a sectional gage, which depended upon the fastening screw to keep the handle from turning, was being used in

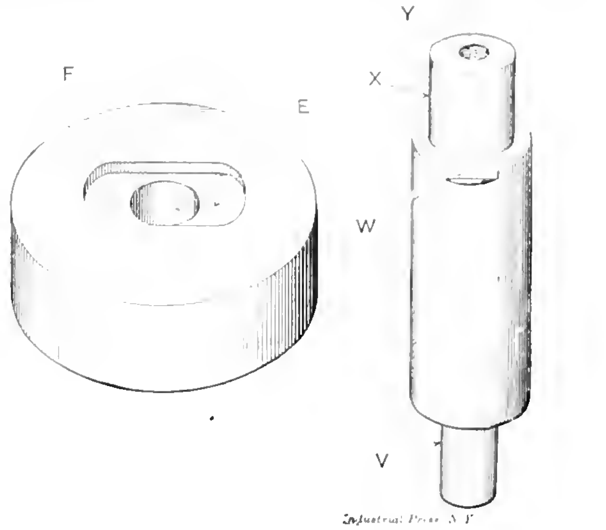


Fig. 3. Fig. 4

a cylinder, which was threaded on the inside at one end, the other end being blind. This particular gage was being used to test the thread, and when it was run part way through it became fast. As soon as the inspector tried to turn it back, the handle became loose, and then the trouble began. The inspector worked for a half an hour trying to extract it, but without success, after which it was turned over to the toolmaker, who finally extracted it after two-and-one-half hours' work. So you see a gage of this kind would not only be a tantalizer but a very expensive tool in the long run.

The improvement on this class of gage shown in Figs. 3 and 4 avoids all such trouble as I have just described. Referring to Fig. 3, which is the plug or male thread gage disk, as the case may be, the disk may be any diameter, generally 1½ inch or over, and any suitable thickness. It is made of tool steel and hardened, with one side end milled about 1-16 inch deep, *E*, with a diameter ⅛ inch less than the diameter of the shank. The shank, Fig. 4, is flattened on both sides 1-16 inch, which allows it to enter the milled slot in the disk, thereby securing the disk so that it is unable to turn on the shank.

One end of the shank is turned for a drive fit in the handle, while the other end is turned to size to fit the hole *F* in the disk. This end is tapped to receive the fastening screw which holds the shank and disk firmly together. The shoulder at this end is flattened to enter the slot in the disk, as just described.

This construction for gages of this class has been in constant use in one of the largest manufacturing plants in the United States for about two years, and has given satisfaction.

W. E. G.

A SUCCESSFUL APPRENTICE.

Editor Machinery:

In the last few months I have noticed several articles about apprentices in various papers and nearly all of them seem to have poor regard for his natural inclinations and habits. Several years ago I had the privilege of working in a shop where an embryo mechanic of the opposite kind came to learn the machinist trade, and with the indulgence of your readers I will try to tell what success he met with.

When Will first came he was placed in the tool room waiting on the men, operating the saw, and sharpening drills. To me, the first thing that distinguished him from his predecessor was that he was very quiet and had little to say to the men; not shy, but reserved—some of the boys said he was

"stuck up;" next, that he always had the room neat and clean and took much less time to serve the men, consequently was of value to the shop, a thing not likely to be overlooked. He remained in the tool-room about two months, during which time a 14-inch lathe was being remodeled. We had decided to put one of the young apprentices on it turning collars and roughing out stock. When it came to deciding which one the foreman said he believed Will was the best, although pretty new; so he got the chance and his steadiness and ability to learn were very gratifying.

He had this job for about a month when several of the men quit and he was advanced to much more particular lathe work, which he did for about a year with much credit to himself.

Then he asked for and was given erecting work, and naturally the same quality of work was turned out, and after he had been at this for about eight months he got an idea he was worth considerably more money, but he and the superintendent could not come to terms, so he found another job in a small shop as a planer hand, his previous experience on this machine being obtained through observation alone.

When he started learning the trade he had only a grammar school education, but he soon realized that it was not sufficient, so he enrolled in a mechanical course with a correspondence school.

The job he took was evidently not satisfactory for I learned shortly afterward that he was working in a drafting room. In the course of a year I secured a job with the same people and I was very much pleased to find that he was successful and was becoming a very good draftsman. We became intimate friends during the next year and decided to go West together. I got as far as the Rockies and Will went to California.

He worked around in different shops and traveled pretty nearly all over the state, in other words, became a tramp machinist. He finally got a good job as engineer for a mining company and advanced from that to assistant superintendent. He held this job for about a year and then took a job with another company and now, a year later, at about the age of 23 years, he is holding a position at $1,400 per year, while I—well I am making good wages, but I guess Will has more "go-ahead" and ability than most of us. B. A.

THE MAN WHO IS THE "WHOLE THING."

Editor MACHINERY:

While visiting one of the large manufacturing establishments of New England, a few days ago, and talking with one of their prominent men, a fact dawned upon me which I had known before, but which I had never before so fully appreciated. That is, that in the majority of concerns each one has its man who is "the whole thing."

We were speaking of a factory which I had visited the day before, for the first time, and referring to my impressions in regard to the place, I said: "Mr. Jones seems to be quite a prominent man over there." "Oh, yes!" was the reply, "Mr. Jones is the 'whole thing' in that shop."

That is just the phrase I have been looking for through all my mechanical experience and if that man had not said it this would probably never have been written. I have known for a long time that in the majority of shops there is one man who has more to say than all the others put together; this is not as it ought to be. I don't mean that there ought not to be one head to every establishment, because I believe there should be, and that from him all general orders ought to go. But they ought to go through their legitimate channels until the detail is properly carried out, and if orders do not go through their proper channels the detail will *not* be properly attended to.

This "great evil," if I might so call it, exists to a very great degree in our manufacturing establishments to-day. I do not know whether or not it is of recent birth, or whether it is growing or dying (the latter, I hope.)

The man of whom we are speaking is usually very busy. Sometimes he is a man who works very hard, is of humble mind, and honestly wonders how the work would go on without him. He does not know how to divide the responsibility of the shop so that he would be the real head, and yet have others decide the more unimportant matters for him. A man once told me about a machine he had designed, and built for drilling a large number of holes in a piece of wood at the same time. He said it had been in operation in the shop for more than a year, and that a boy could run it, but that he (the designer) had to grind all the drills himself, and as he was foreman of the shop, he had to hustle to look after his work, grind the drills for the machine, and attend to the other duties which only he could do. I suggested that he teach the boy who ran the machine to grind the drills; he replied that he did not believe the boy could do it right. A few months later he told me that the boy was grinding the drills and was doing it just as well as *he* could.

Then there is the man who is the "whole thing" and who delights in it. He likes to handle every matter so that at any moment he can come forth, and give an order to do it this or that way, regardless of all previous orders. This is the most dangerous man of all the list. Most dangerous to the welfare of the business, and most dangerous to the dignity and efficiency of those in charge under him. He gets his subordinates after a while, so that they are afraid to express an opinion in regard to the work, unless they can say: "This is the way *he* wants it." That word "*he*" is the most despicable (to my mind) of all those used by men who are looking after work. It does not make any difference to the man who works for me how the man above me wants it done. The only thing that concerns him is as to how I want it done. And if he does it according to my instructions his responsibility is ended.

I was shown through a factory not long ago by a man who was called the assistant superintendent, but that was not his real position. His real position (if you will permit the genuine truth) was errand boy, or since he was a full grown man "errand man." I do not wish to reflect discredit upon the man in question; the trouble was with the man who hired him, and for whom he worked. I do not know what his motive was, if indeed there was a motive in having his so-called assistant so helpless. Perhaps he might say he was not qualified to take any responsibility. Well, if he was not, why did he keep him? When speaking of the various fixtures, and methods in use in the factory this superintendent would say: "This is how 'he' likes to have them made," or, "I don't just know what his idea was in making it this way, but I guess it is all right." And on another occasion: "Mr. Jones is a great believer in this method of doing a certain thing, and I don't know but I am almost convinced myself that it is the best way, ha, ha, ha."

Now, I like to have my employer tell me what he wants and then give me a clear field to think the matter out. Then I can go at it with a will, take an interest, and bring the work out much more satisfactorily than if he should limit my horizon with detailed instructions which are unnecessary. I like to give a man a piece of work and tell him to do it right, and quick, and that he will not hear from me until the job is done, unless he asks for help or instructions.

A common expression among employees of a man who is the "whole thing" around his plant, is: "Come and look at it for yourself." I have known his foreman a number of times to send a man up to him after completing a piece of work and ask him to come down and look it over. The foreman knew very well that his judgment on the matter was likely to be overruled. So far as I can see, in all cases the man who is the "whole thing" is to blame.

To show the general helplessness of the errand man, caused by the man who is the "whole thing" I will cite a case which came under my observation while a very small boy. A contractor and builder sent a man in charge of a number of carpenters to remodel an old building, with instructions to put in new whatever parts of the building ought to be made new. Now the rub came in in the clause "ought to be made new." The man knew right well that his judgment was more liable not to be accepted than otherwise, and that when the man who was the "whole thing" came, there would most likely be a change of plans. So he was careful not to do much real work until he came around and, in his endeavor to get his employer's mind on all points, as they approached the build-

ing he looked up and said. "Is that post sound?" "What post?" asked his employer. "That rotten one(!)" was the earnest reply.
C. M. C.

SOME LATHE FEATURES.

Editor MACHINERY:

The heavy cuts that have been attempted recently have developed a number of weak points of the lathe. In the first place many lathes chatter excessively on large diameters; this is invariably caused by the fact that the carriage overhangs the bed. The thrust *P*, Fig. 1, of the tool, tends to bend the carriage down on the outside. This can readily be seen on many lathes while the machine is taking a heavy cut on a large diameter and especially when the cut runs over slots. The movement of the carriage up and down is quite perceptible. Fig. 1 represents a construction commonly seen on lathes. The apron *A* is held to the carriage by small bolts

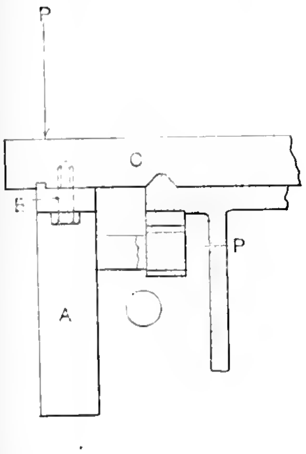


Fig. 1.

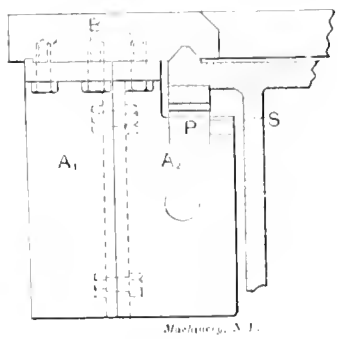


Fig. 2.

B, which upon investigation will be found to be too light. There is a very severe thrust brought upon this carriage when the pinion is pushing the carriage along the rack, against the heavy cut, and the thrust of the pinion *P* against the rack tends to twist the apron out of place. It will also be seen on these lathes that the pinion *P* overhangs the support. In a number of cases, the pinion shafts have become bent and the aprons have been broken. This is not likely to occur on small toolroom lathes, but on 36-inch lathes and above, these things have happened.

Fig. 2 represents a construction of the apron which embodies a number of good points. In the first place the apron is supported by a sufficient number of bolts *B*, and the apron itself is arranged in two parts, A_1 and A_2. The latter extends around the leadscrew and forms a support *S* for the pinion *P*

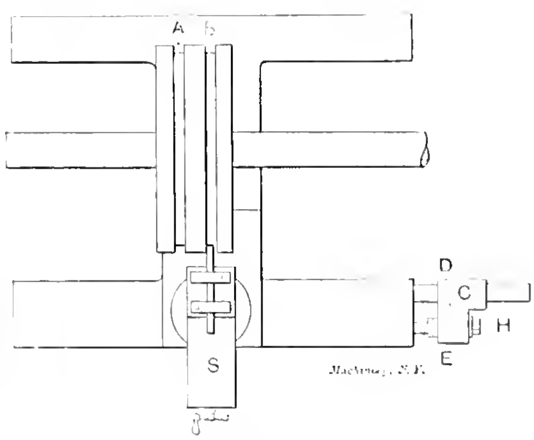


Fig. 3.

This prevents the pinion from bending over on the end. At the same time there are a number of other shafts extending through the apron which are thus supported on each end.

On large lathes the weight of the carriage and the accessories belonging to it are considerable. To move this carriage along the ways by hand requires considerable energy even though the gear ratio from the handwheel to the rack is high. One prominent lathe builder employs a ratchet lever in connection with the handwheel; we thus employ a much longer lever arm and consequently get a more even movement of the carriage with, of course, a proportionately less amount of exertion.

It frequently happens that the lathe hand is obliged to move the carriage along the ways in order to get the proper width for grooves, etc. Fig. 3 represents a piece of work of this

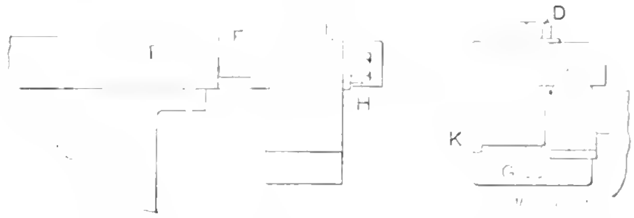


Fig. 4. Fine Adjustment Device for Lathe Carriages.

character. The grooves *A* and *B* must be of a definite width and must be located to suit given dimensions from each other and from the edge of the piston. It is not an easy matter to move the heavy carriage along the ways in order to obtain these exact dimensions; we will either get too little or too much as the carriage moves along the ways by jerks. Since the swivel head *S* must be used as shown, the only method is to move the whole carriage. The lathe hand having experienced difficulty in getting the tool located properly, will invariably get it approximately right and then pound the carriage back and forth, as the case may require, with a soft hammer; and if a soft hammer is not at hand, it will be bumped with a bar or hand hammer, which cannot help but mar the carriage.

The arrangement illustrated at *C* Fig. 3 can be put on all new lathes and on a great many old ones. *C* is arranged in the form of a clamp and by means of a bolt *D* it can be fixed in any position. *E* is an adjusting screw which has a hexa-

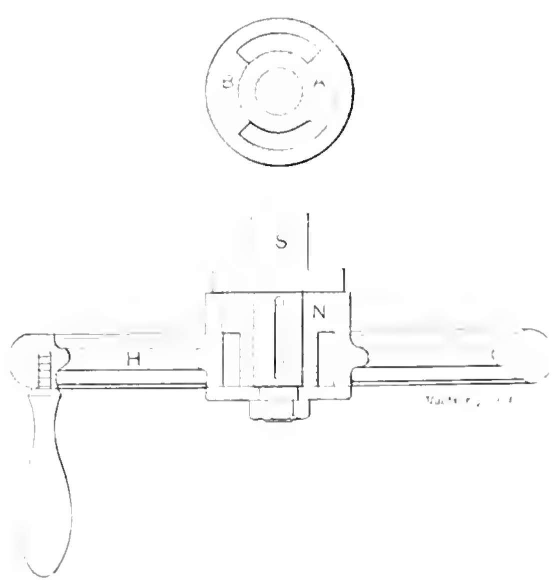


Fig. 5. Handwheel Construction for Easily Loosening Friction Clutch

gonal head *H* as indicated, and it can be made to fit the standard tool clamp wrench. By means of this screw the carriage can be adjusted to almost any degree of fineness. The head of the bolt *D* can be made to fit the same wrench; a quarter turn one way or the other will either lock or loose the clamp. When the clamp is loose it slides back and forth on the ways with the carriage. A detail of this clamp is shown in Fig. 4. The adjusting screw *E* has a long tap *F* into the carriage. The clamp bolt *D* extends through the clamp proper and is threaded into the gib *G*, which in turn clamps against the under side of the rack. The clamp should be cut away except the small portion *K* in order to give a better clamping effect.

In locking and unlocking the friction from the cross-feed and traverse, in the apron, difficulty is sometimes experienced. In taking cuts the friction must be clamped so tight, in order to keep it from slipping, that it is necessary to hammer the friction in. Of course, when the tool is rapidly digging into

some portion of the work, it cannot readily be knocked out, and a spoiled job is apt to be the result.

In Fig. 5 is shown an arrangement for knocking in and knocking out the friction. *S* is the friction shaft, *N* is a nut, while *H* is the handwheel. The nut *N* has a lug *A* extending outward on one side as shown. The hub of the handwheel *H* has a hub *B* extending inward on one side as shown. It is possible to turn the handwheel through half a turn before the two lugs *A* and *B* come in contact. Once the handwheel is turned so that the hub *B* bumps against *A* any further movement of the handwheel in the same direction will turn the friction shaft *S*. When the friction cannot be drawn tight enough, it can be hammered into place by moving the handwheel back and forth and thus knocking the shaft around until the friction ceases to slip. If the friction is thrown in and the tool accidentally digs into the work, we do not need to hunt for a hammer, but just simply throw the handwheel around and as there is some weight in the handwheel, one knock will disengage the friction.

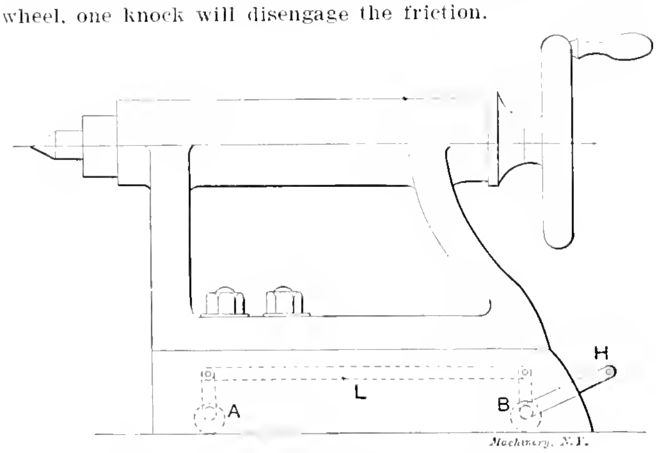


Fig. 6. Anti-friction Attachment for Tailstocks.

As it is difficult to move the carriage along the ways for a considerable distance, it is frequently pulled back and forth by the leadscrew; the tailstock, however, must be pulled along by hand, either by a crank directly connected to a pinion or else by a crank connected to the pinion through intermediate gearing. We can readily obtain any amount of gear ratio and can readily bring the pull at the crank within any desired limit in order to move the tailstock. In gearing this up, however, we lose too much time in moving the tailstock along. A good arrangement is to place a crank directly on the pinion shaft and then place two pairs of eccentric rollers as shown at *A* and *B* in Fig. 6. *H* is the handle which revolves the eccentric and raises the tailstock slightly off the ways. The link *L* connects the eccentric shafts. The lift need not be more than 1-32-inch—just enough to take the weight off the ways. The friction will thus be reduced so that the high gear ratio will not be necessary. The operator can thus readily move the tailstock from a short to a long piece of work and *vice versa* without much fatigue.

FRANK B. KLEINHANS.

CARBORUNDUM WHEELS.

Editor MACHINERY:

Carborundum wheels are cutting material, and not grinding, as usually applied. They are composed of thousands of miniature carborundum chisels, or cutting tools, hard as diamonds (even cutting diamonds), with keen, sharp, cutting edges, placed promiscuously and in every conceivable position throughout the wheel. Many of these cutting edges are just in the proper position to do excellent work on any kind of metal, or material, usually finished up in this way. Experiments have proven that the coarser the grit the more satisfactorily the work is done, but it is necessary to have the wheel balanced, clean, true and firm on a steady running arbor.

I recently was asked to make some tests on soft steel and cast-iron with a No. 16 grit wheel for a party from Cleveland, O. After making a satisfactorily smooth finish on the soft steel, and before starting on the cast-iron, I touched off the face of the wheel with the diamond. I was asked, "Why do you do that?" I replied, "To insure a true and clean face of my wheel," and was told, "That won't do; the wheel must work on either stock without having to first true it up." While this remark was made by a gentleman who admitted on a previous occasion that he knew little about the use of wheels, it is often only too true that the manufacturers, who should know better, expect too much for nothing. One might, with the same propriety, say there is no use in properly fitting the tools for the various kinds of work, and finish, on the materials worked on the lathe, planer, shaper, drill-press or miller. No good mechanic will even attempt to use a tool on any machine without first preparing the tool for the particular job he intends doing.

Now, it does not follow that a carborundum wheel with its thousands of small cutters (which, when in order, do more and better work than the tools just referred to) should be deprived of the very trivial attention of simply keeping its face clean and true. Rather, were it necessary, give it more attention, since its cutters do so much more and better work. Tools of any kind, however good, must be kept in proper order to do good work.

A 12 or 16-grit carborundum wheel is well adapted for almost any class of work when requirements, as above stated, are complied with, for either roughing down or finishing. Of course, for a fine finish it requires to be run without any feed till the sparks cease to show, and with sufficient water, to prevent the work from heating. All wheels will heat more or less when used without water, and the work will expand and continue to cut away the stock, as it heats more and more, and is liable to be spoiled, especially where accuracy is required.

A wheel that will glaze heats, of course, much quicker than one that will not; much care and attention to the keeping

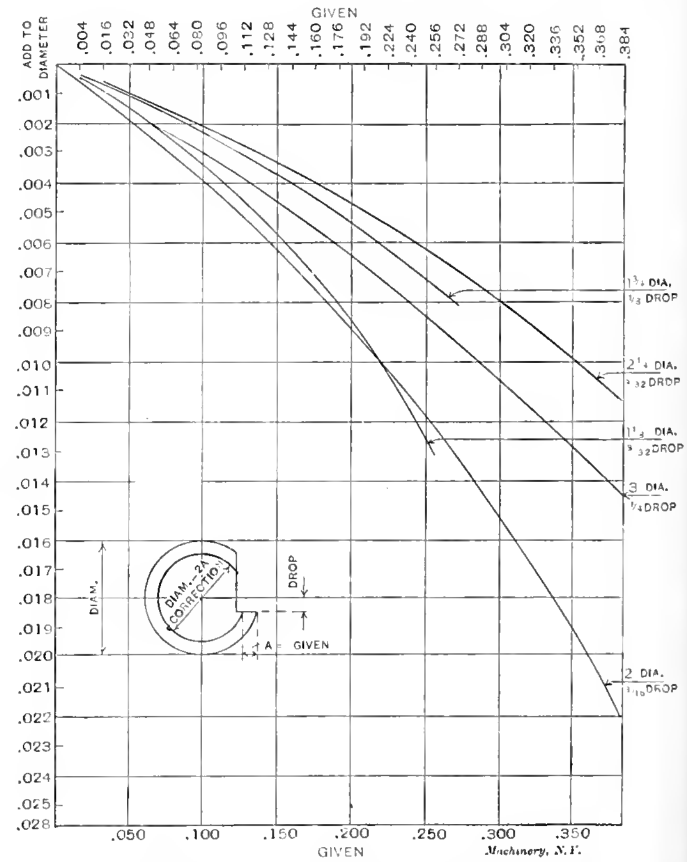


Fig. 1. Chart for Circular Forming Tools.

in order of both wheels and machine must be given. As before stated, arbor and wheel must run true and steady. When you are depending on the small cutters or chisels to make a neat finish they must necessarily run steady, so that the periphery of the wheel does not vary in its travel, otherwise a good finish with a coarse wheel cannot be expected.

Again it must be remembered that there is a difference in finishing work—holding it on the wheel by hand or rigidly holding it between centers, or in a vise or chuck. It would be a hard matter to get a fine finish with a coarse wheel simply by holding it on by hand, as the pressure would be irregular against the cutters. A good finish by hand, how-

ever, is easily obtained by the use of a carborundum buffing wheel of 36 or 40 grit.

I would be glad to hear of the experience of others who are using carborundum as cutting tools. EZRA F. LANDIS.

La Salle, N. Y.

CHARTS FOR FORMING TOOLS.

Editor MACHINERY:

I have read with much interest the article "Straight and Circular Forming Tools," by Mr. J. M. Stabel, as found in the June, 1904, issue. As it falls to my lot to design tools of this character, I have a suggestion or two to make on the tables that he has had appended.

Table No. 3 is gotten up very well; we have a wide range in diameters to select from, with various depths of cutting faces below the center, etc., but unfortunately the value of this table is limited. First, let us glance at Table No. 1. Here we can find the correction for any distance for *a c*, up to ½-inch varying by 0.001 inch. For an odd figure the method of arriving at the correction by means of adding the constants, is not really first-class, as there is that element of danger of an error in the adding operation. Let us now refer to Table No. 3. It is just as necessary to have the correction known, for distance *B C*, varying by 0.001 inch as in Table No. 1, but this table is calculated for *B C*, being either 1-16, ⅛ or ¼ inch, and you may make dozens of forming tools and not have use for the table.

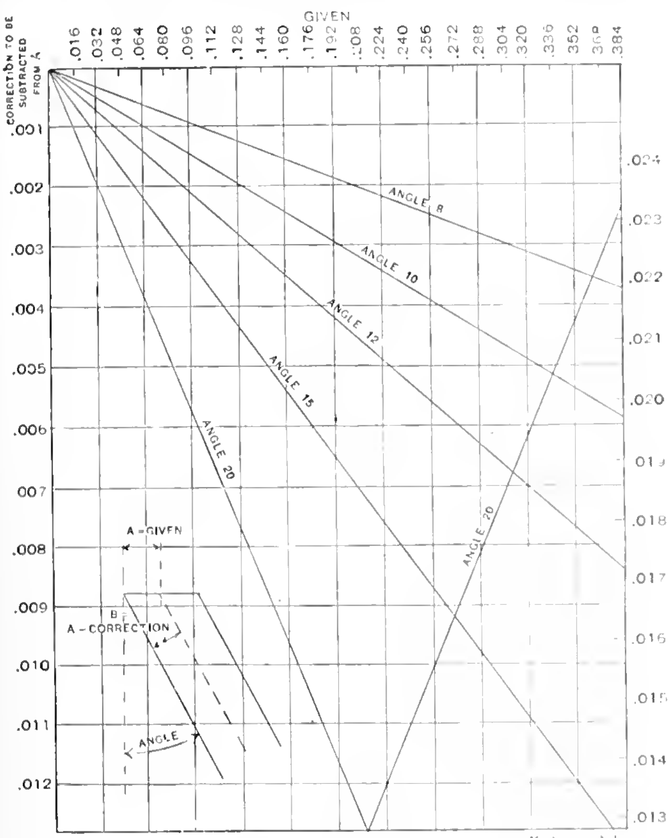


Fig. 2. Chart for Straight Forming Tools.

Accompanying are two charts that I have designed; the various curves and lines thereon are made from what I know to be generally used. I will give an illustration of their use as the best way to explain them. Referring to Chart No. 1, the distance *A* (see sketch) thereon is calculated from whatever the piece is, we have to make. Under the word "Given," at the top and bottom of the chart, locate *A*, and follow down (or up) the vertical line until it intersects the proper curve. This point carried to the right by the horizontal line, will indicate the correction to be added to the diameter, after subtraction 2*A*, of course. The horizontal divisions for the verticals vary by 0.004 inch, and the corrections read to 0.0005 inch, which for practical use is as near as required.

The same illustration will answer for Chart No. 2; in this the correction is carried around to the right of chart.

The Chart No. 1 shows only five curves and there is no question but what there are many other standards, so it is quite impossible to make a complete chart or table. This one covers the range of my experience in automatic and hand screw machines. For instance I use a circular tool 2¼ inches diameter and 5-32-inch drop as much as any other; on straight tools I generally use angles of 8 and 12 degrees, seldom 10 or 15 and never 20 degrees. Unless we know all standards I think it best to avoid useless calculations.

GEO. D. HAYDEN.

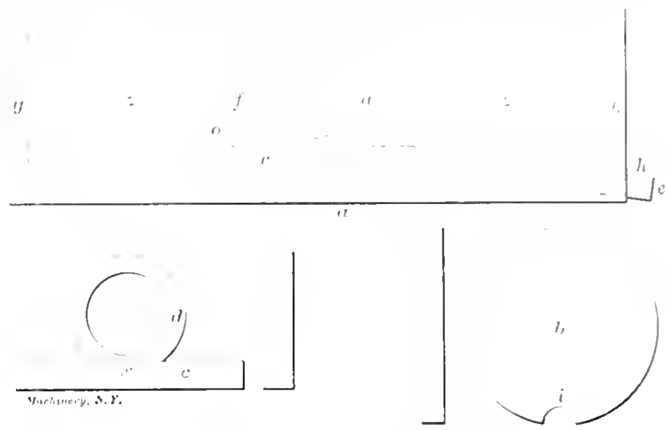
New Bedford, Mass.

MUFFLE BRAZING.

Editor MACHINERY:

Oftentimes in model and experimental work it is cheaper, and better in most cases, to braze two pieces like *c* and *d* together at *x*, than to make the shape out of solid stock.

I made a pot *a* of suitable length out of iron pipe, and had the bottom *g* welded in, to make it air-tight, as all air must be excluded to make the job a success. Then I took a piece of ½-inch gas pipe, *h*, cut it off to the right length, and closed the end at *o* with an iron plug. The top of the pipe *h* was



Apparatus used in Muffle Brazing.

filled for a distance of ½ inch with brass filings, *f*. *c* and *d* were firmly secured together with iron wire, and brass filings were placed around the joint at *x*. The job was wound up with cotton cloth and string to keep the charcoal off the work, and was placed in the pot *a* so that *c d* and *h* would come central in *a*. *h* was placed on a slight incline, as shown. The remaining space in *a* was filled with clean charcoal. The cover, *b*, which is milled out at *i* to allow *h* to pass by it, was put in place and luted with fireclay. The muffle was then placed in a furnace. When the work has attained the proper heat the brass filings *f* will melt and run down the incline in the gas-pipe, *h*, and out at *e*, and in coming in contact with the air will emit the characteristic blue-green flame which indicates that the brazing material has reached the liquid state.

The operator should then wait a short time after the brass has flowed to make the job sure, then take the pot out of the furnace and lay it aside to cool. After taking the job from the pot, it will be found to have a perfectly brazed joint, and as clean and bright as a new silver dollar.

New Haven, Conn. A. L. MONRAD.

[The old-time German locksmiths practiced muffle brazing to a considerable extent, but the muffles they used were made of common clay. Suppose a key of complicated shape was to be made. It appears, from what the editor has been told by one of these old-time locksmiths, that the common practice was to build up such a key from bits of iron arranged to form the projections to fit the wards of the lock. These, of course, were filed to shape afterwards, but by the building-up process it appears that considerable labor was saved on account of the simplicity and sureness of the clay muffle brazing process. When the parts of the key were built up, they were firmly bound together with wire, and brass filings were placed around the joints. The whole was then luted with clay, forming a mass considerably larger than the work. This was put into the forge and heated until the brass flowed, which was known by the color of the flame; then the whole mass intact was removed and allowed to cool before breaking apart. The process is said to have been absolutely sure every time, and one easily learned.—EDITOR.]

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A DRAFTING KINK.

Here is an expedient in making scale drawings, which, while very simple, seems new to almost every one I meet. If drawing circles of scales half size or smaller I take the radii off directly from the scale of half the size I am working from. For instance, suppose that a drawing is being made half size and that a circle of 18$\frac{5}{8}$ inches diameter is to be drawn, I set the compasses to 18$\frac{5}{8}$ inches on the 3-inches-to-the-foot scale and they are set right without any calculation or chance of mistake. If working with a scale of 1-inch-to-the-foot then I lay off radii on the $\frac{1}{2}$-inch-to-the-foot scale and so on. Compare this with dividing 18$\frac{5}{8}$ inches by 2, and the saving in time and gray matter will be evident. E. H. Fish.

Paxton, Mass.

SIMPLE BALL REAMER.

To make a fluted ball reamer of the ordinary style requires considerable time with the facilities at hand in most tool rooms and to make it so that it will be accurate a great deal of care must be exercised, but here is one which is inexpensive, easily made, and it will bore an almost perfect ball socket. This style of ball reamer has been used by one of the local firms for years and has always given good satisfaction. A piece of steel is turned to the desired size and a cut-off tool partly forms the disks. The disks are then finished, as in Fig. 1, on the outside, making a slight shoulder on either side and cutting a shallow angular groove around the center. They are then further separated by cutting in with a parting tool again as far as possible without bending the steel, after which

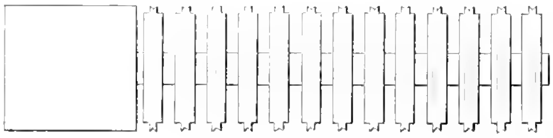


Fig. 1

Fig. 2

Fig. 3

the disks are faced off to a uniform thickness and cut apart with a hacksaw. The roughness left by the hacksaw is smoothed off on an emery wheel. Each disk is filed away on one side of the angular groove for nearly one-fourth the circumference, then the alternate side for nearly one-fourth, and so on entirely round the disk, allowing cutting edges to lap a trifle, as in Fig. 2. They are then ready to temper. The cutters are held simply by being driven into the holder, Fig. 3, and are used until dull, when they are given a half turn and fresh cutting edges are presented to the work. With careful usage one cutter will last a long time.

Salem, Ohio. Roy W. Harris.

SCREW CUTTING WITH THE FEED GEAR.

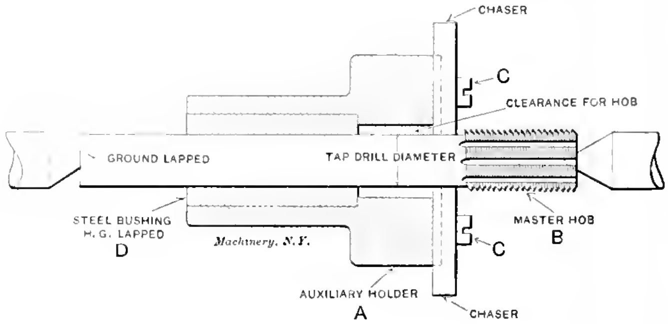
Many articles have been written about screw-cutting, but the following may be new to some of your readers: I was employed at one time in a little mining camp repair shop, the only lathe being 26-inch swing; the finest pitch that it would cut was twelve threads per inch and no provision was made for compounding the gears. One of the first jobs I had was to make a new needle valve for a lubricator, the threaded part being about $\frac{1}{4}$ inch diameter and 24 threads per inch. I placed two gears of the same size upon the stud and screw and started the feed, the friction being driven through leadscrew. Counting the number of revolutions to 4 inches of travel of carriage I found 80 revolution to 4 inches, or a feed of 20 per inch. Taking that as a base the same as if I had a 20-thread leadscrew, gave the proportion 20:24 = 40:48.

A 40-tooth gear was put upon the stud and a 48-tooth gear on the screw, which gave the desired pitch.

At another time I had to repair a drill grinder chuck; the thread on the spiral or scroll plate had been broken out. The old spiral was faced off and a steel plate was fastened on in which a new spiral thread was to be cut, the pitch being $\frac{1}{2}$ inch double thread. The lathe to be used was a Putnam—one of those in which the driven gear on the stud slid upon a feather that it might be driven either by a gear on the cone or by a gear of the same size on the lathe spindle. The cross-feed was driven through the screw. Two gears of the same size were mounted on the screw and stud and starting feed the revolutions were counted. I found the cross-feed tool block moved 5 inches for 35 revolutions of the lathe spindle, or equal to 7 threads per inch. Using this for a base the same as if I had been using a 7-thread leadscrew gave the proportion 7:2 = 70:20. Having those gears I used a 700-tooth gear on the stud and a 20-tooth gear on the screw, and thus gained the desired result. J. T.

RECUTTING THREAD CHASERS.

For those who are interested the accompanying sketch will show more thoroughly the manner in which thread chasers can be accurately re-cut than would be possible in a briefly worded description. *A* is an auxiliary holder, of machine steel, having slots cut in same to fit chasers, and it also contains a steel bushing, *D*, that is hardened, ground and lapped. The master hob, *B*, is made having a long shank which is ground and lapped to fit the bushing. The diameter of shank



is same as that of tap drill for chaser to be cut. To re-cut chasers remove same from slot in die head proper, and after annealing, the chasers are placed in slot in auxiliary holder and the master hob also is placed in holder, as per sketch. The chasers are now brought to bear against shank of hob and securely tightened by means of screws, *C*. The hob can now be made to cut chasers in same manner as an ordinary tap and the long bearing in bushing *D* insures accurate results. Two hobs should be used, one to remove stock, and one to cut finished sides. It is almost impossible to obtain accurate results if the chasers are cut independently, on account of the difficulty experienced in getting the threads of the different chasers to match up when in place in the die head. The above fixture was designed by the writer for cutting chasers used in self-opening dies and the method is perfectly reliable. Frank E. Shailor.

Great Barrington, Mass.

ANOTHER "HARDENING WORK IN PART."

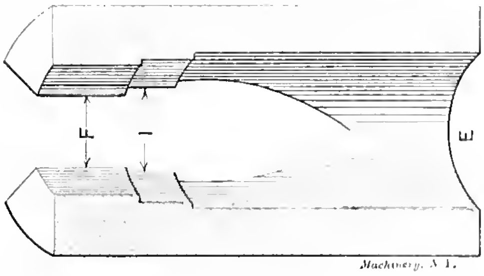
As Irm J. says of the letter from O. M. B. in regard to hardening work in part, "There is perhaps one shop in fifty that is equipped to turn out work in that way;" and Irm J.'s method would work only on steel that had sufficient carbon in it to cause it to harden. What is the use of going to all that trouble, even if you were fitted to do it?

Suppose you have a piece of shafting that you wish to harden where the bearing comes, and do not care for the rest to be hard. Locate the bearing and put that part in the fire and heat it to a cherry red, and put on it some cyanide of potassium and let it run around over the part you wish hardened. Then take the piece from the fire and cool it quickly with water, as you would if it were tool-steel and you wished

to harden it, only in this case you do not need to draw the temper. This way is much easier and any shop that has a forge can do it as well as the best equipped shops. C. H. A.
New London, Conn.

TO PREVENT SPRING DIES CLOSING IN.

I have read Mr. Markham's articles with much pleasure and have received a great deal of benefit from them, and I wish to call his attention to this method of overcoming a troublesome feature of spring dies. Having a great deal to do with this class of dies I find that when hardening them they have a tendency to close in at the top, which makes the die under size; and to overcome this, I use the methods here shown in the sketch, which shows a sectional view before threading.



After having them all finished and ready to temper, I heat the dies to a low heat and drive a piece of punch rod into the portion *I* which is left enough smaller than *E* to make a driving fit. This forces the die outward and just enough to counteract the closing in, so after the die is tempered it comes back to its normal state. We had a great deal of trouble with our dies until this method was used and now we have no trouble at all with them. I have seen a great many dies thrown away on account of their closing in, and where one makes the dies and never gets a chance at tempering them, he hardly ever knows whether they are good or bad, for when a die does not work just right, the men usually throw it away and get a new one. W. Van Orman.
Lorain, Ohio.

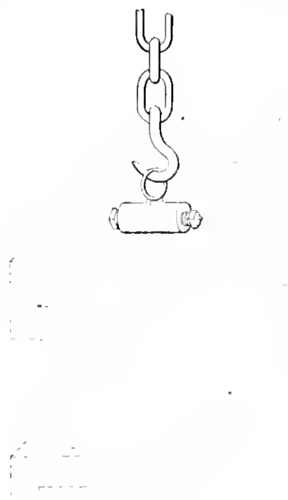


Fig. 2

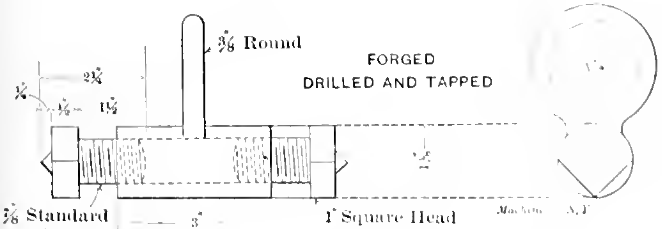


Fig. 1

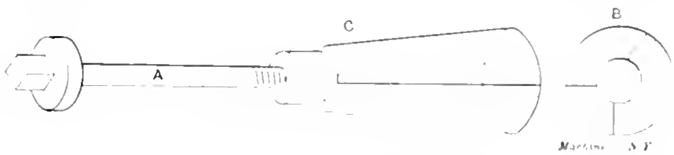
DEVICE FOR LIFTING DRIVING BOXES.

The sketch herewith shows device for lifting driving boxes, and although it is a small device, still it is one of the best shop kinks that I have ever seen in a railroad shop for this purpose. It is something of my own design and has been in use for the past three years, proving very handy for lifting driving boxes on and off machines, and also in fitting driving boxes to driving journals on the erecting side of the shop. By the introduction of a small traveling crane over pit, which is used for fitting the above mentioned boxes, and a small air hoist, an apprentice boy, without the assistance of a helper, can apply a driving box on one of the modern engines without any effort.

Fig. 1 shows the construction of the lifting device, which can be made of wrought iron or steel forging, or a brass casting. By simply drilling a hole through the body, tapping out and inserting two setscrews, the device is completed, and after the setscrews are imbedded into the flanges, it is impossible to pull away. The cost of making this device is very little. Fig. 2 shows the device in operation, and the manner in which it is applied in the driving box. Prior to using this I was compelled to use chains and clamps of different styles and rude construction. L. C. Hicks.
San Bernardino, Cal.

CHUCK FOR HOLDING END MILLS.

I saw in July issue of Machinery a description by Mr. Ridderhof of a chuck for holding end mills, which is without doubt a very good tool for the purpose; but I have made and used one for the same purpose, and often wondered at people being satisfied with the old taper shank mills which Mr. Ridderhof justly criticizes. I herewith submit a rough sketch of the one which I prefer to all others I have seen and which, if made accurately from good machinery steel, will remain practically accurate for an indefinite time, if reasonably used. The mills to fit it are cheaply made, being straight shanks that may be ground true after tempering, and they may be allowed to project more or less to suit the work in hand. The chuck body, *B*, may be made any size to suit the hole in the main spindle or the vertical attachment; if for the large hole, chamber out at *C* to allow it to spring and clamp the shank firmly the whole length. Bolt *A* is of any length to suit. L. E. Muncy.
Syracuse, N. Y.



TURNING SHAFT LONGER THAN CENTER DISTANCE OF LATHE.

Not long ago we had a shaft 4 inches square by 15 feet long that had to be turned to 3 15-16 inches diameter, about 1 foot at one end and 3 feet at the other. The largest lathe in the shop then, would take but 12 feet between centers. I finally planned a way to turn it as follows:

We had a cathead similar to that described by J. J. Dawson in the July number, only that it had four setscrews in each end. By the way, I wish to make a suggestion in regard to such catheads. The ends where the screws go through should be made quite heavy; otherwise in tightening them on the work, the pressure from the screws is liable to spring the cathead out of true, making it slightly oval; and that would likely cause trouble with the steady-rest.

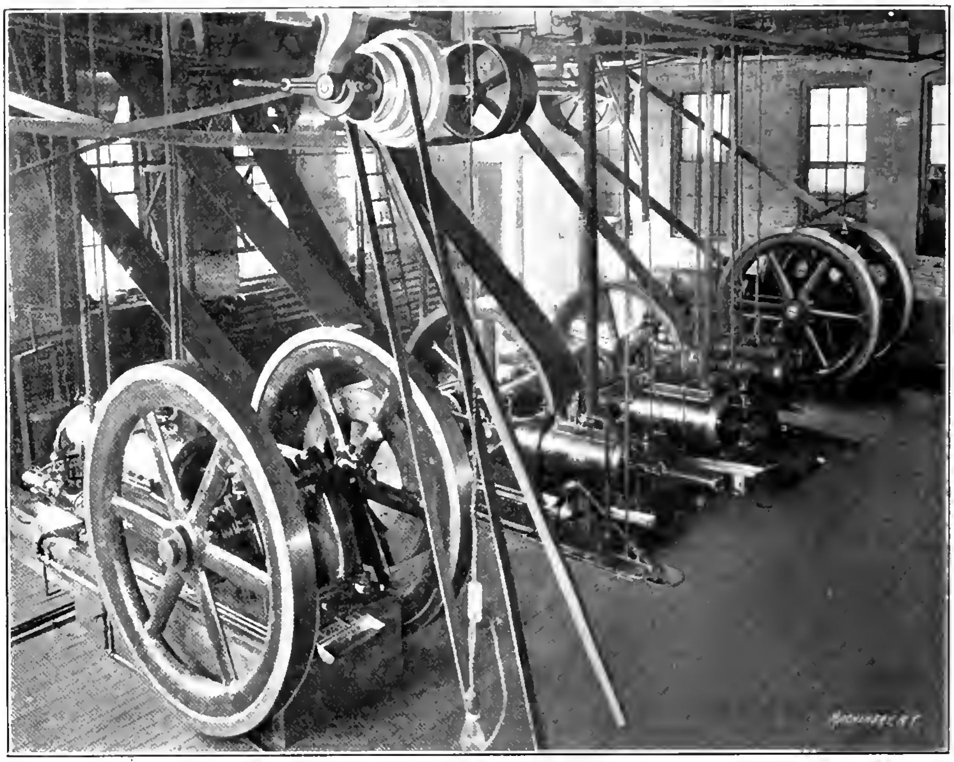
I first took a short piece of shafting that was centered, and slipped the cathead on it, and then put the piece in the lathe on centers. After adjusting the cathead till it ran true I adjusted the steady-rest to it—which centered the steady rest. I then removed the cathead, short piece of shaft, and the tailstock from the lathe, and slid the steady-rest down to the other end of the lathe and clamped it there. Slipping the cathead onto the shaft, I hoisted the shaft into the lathe and chucked one end and let the end with the cathead run in the steady rest. It was then easily trued by the chuck at one end and the cathead screws at the other, and then the end nearest the headstock was turned, after which it was an easy matter to change ends and turn the other end. The shaft had a couple inches in length to spare, and that gave enough to chuck. The ends, of course, were not turned, but were sawed off later, leaving the two ends turned to size, and in line and true. C. H. A.

GAS ENGINE POWER PLANT.

The works of the Star Drilling Machine Company, at Akron, Ohio, are of interest, as it is one of the few large plants operated entirely by gas engines. The power plant consists of four 60 and one 35-horse-power Columbus engines, making a total of 275 horse power. These engines are so distributed throughout the various departments as to reduce the amount of shafting to a minimum. Altogether they constitute a unique installation for so large a manufacturing plant.

One 60-horse-power engine operates the wood-working machinery, another of the same size operates the metal-working department, and the 35-horse-power engine operates the lighting plant. The other two 60-horse-power engines shown in the illustration drive air compressors to operate drop hammers, formerly operated by steam, and all the other pneumatic tools, such as drills, chipping hammers and hoists.

Mr. Miller, superintendent of the Star Drilling Machine Co., states that they find this division of their power very convenient, as they can run any part ot the plant without operating the balance, and having no long lines of shafting, the loss by friction is small and the cost of attendance, fuel and supplies much less than with the steam plant which has been abandoned. The gas engines in this plant were installed by the Columbus Machine Company, of Columbus, Ohio.



Gas Engine Power Plant of the Star Drilling Machine Company.

STURTEVANT ECONOMIZER.

As a natural consequence of their mechanical draft apparatus the B. F. Sturtevant Co., Hyde Park, Mass., are to manufacture an economizer. While the economizer is adapted to installations with or without mechanical draft, special attention is given to equipping power plants with the combined apparatus. In order to adapt the economizer to every possible condition it is built up of sections, with pipes staggered to intercept the gases to as great an extent as possible. There is also built what is termed a Pony economizer, designed to give the smaller power plants from 50 to 300 H. P. capacity an apparatus adapted to their needs. The headers supporting the different pipe sections are carried by so-called wall boxes, which are placed in the side wall of the setting, forming a part of the wall. The whole weight of the economizer is carried by these wall boxes and is thus distributed throughout the length of the setting. Practically all the joints are metal to metal, with taper fits, which facilitates making the repairs.

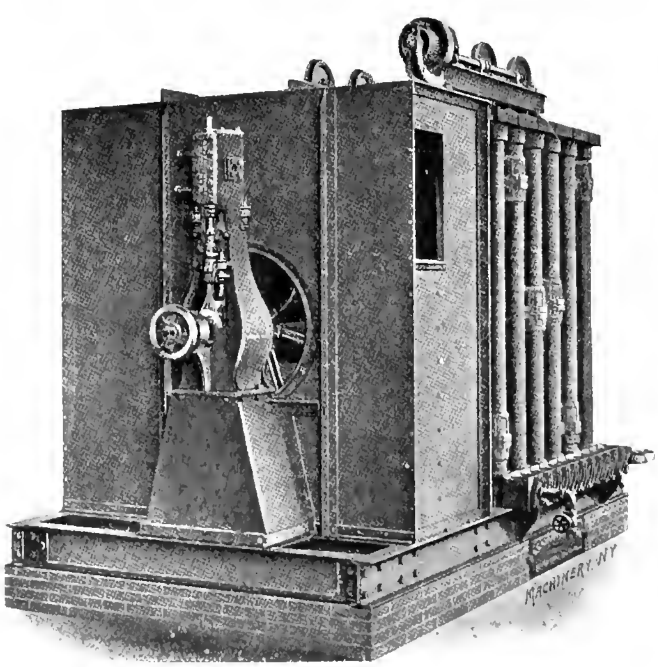


Fig. 1. Sturtevant Economizer.

In Fig. 2 is a diagram showing the process of removing an old tube and inserting a new one. Pipe No. 1 is shown in position, with the inside cap in place at the top. No. 2 is a cross-section of the pipe in position. No. 3 shows the draw-out rods in place to start the pipe from its friction joints. The left-hand rod has a hook which fits under the lower edge

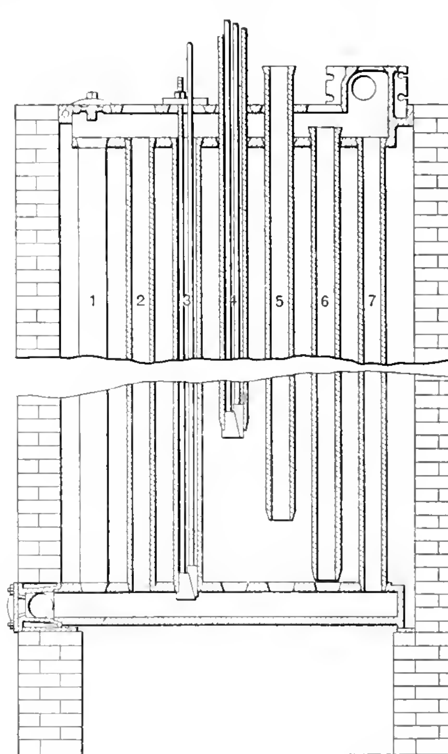


Fig. 2. Diagram showing Method of Replacing Tubes in Sturtevant Economizer.

of the pipe and is wedged in place by the taper end of the right-hand rod. By merely turning the nut at the top the pipe is started from its position. No. 4 shows the pipe removed. Nos. 5 and 6 illustrate the new pipe entering and No. 7 the new pipe in place. By hammering the pipe in slightly the joints become tight. The economizer is fitted with scrapers which automatically travel up and down the pipes. They are operated by an improved form of reversing apparatus.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

8. H. S. has sent us a sketch showing two methods of connecting two shafts, and wishes to know which will prove the more efficient and about what the losses will be in each case. In the first example a gear wheel with 31 teeth drives one with 13 teeth, and on the same shaft with the latter is a sprocket wheel 12 inches in diameter which is connected by a sprocket chain with a wheel 6 inches in diameter on another shaft. In the second example the two shafts are connected by a chain drive without any intermediate gearing. We think it probable from the sketch that the gear wheels have cast instead of cut teeth and that the sprocket chain is of an ordinary type. Under such conditions we should expect the loss to be about the same for a sprocket drive as for a gear drive. Assuming the loss for the gears to be 15 per cent., and for the sprocket drive 15 per cent. also, the total efficiency in the first example would be $.85 \times .85 = .72$. The efficiency of the direct drive in the second example would be about 85 per cent.

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9. S. C. Co.—Will you kindly advise us what is understood by the amount of power conveyed by a "run of stone?" A good many property rights in water power have in the past been conveyed under the description of "so many run of French buhr mill stone and the necessary machinery," and we would like to get the best statement of the amount of power which engineers agree on as being covered by such a term.

A.—We have submitted this question to Mr. Samuel Webber, who, for so many years was identified with mill work and power transmission, so that he is unusually well qualified to supply the information requested. He replies as follows:

I have devoted a great deal of time to this question, and looked up every available authority, from old Nicholson's "Operative Mechanic" down, coming to the conclusion from the older authorities that "one horse power per bushel of grain, ground per hour" was an average rule. This was verified by the results of the test of an automatic engine at the mill of Gibson & Co., at Indianapolis, published in Van Nostrand's magazine for December, 1877. In this article the mill was stated as containing "12 runs of 48" French buhr stones, and the consumption was $7\frac{1}{2}$ to 8 bushels wheat per hour. The power used by indicator cards was: Condensing, 105.4 horse power; non-condensing, 115.4 horse power. This included cleaners, bolts, etc., but in the non-condensing trial the elevators were worked more steadily than in the condensing one. This gives in the non-condensing trials a little less than 10 horse power per run; in the condensing trial a little less than 9 horse power, and deducting engine friction, about 9 and 8 horse power respectively. So that I have called the water power required from 8 to 10 horse power per run, according to the character of the wheel, whether modern turbine or old breast. For the old deeds, when breast wheels or overshots were in use, I usually call it 10 horse power per run.

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10. O. W.—Will you kindly tell me the fusing point of aluminum, and if it can be molded. Also the sand to use for a green sand mold. Will chilling have any effect upon the mold?

A. We submitted this question to the Pittsburg Reduction Co., who reply as follows:

The fusing point of pure aluminum is 1,250 degrees F. Aluminum can be cast in both sand and metal molds as readily as brass, and in general castings can be satisfactorily made by the use of an ordinary sand mold, such as would be used for brass casting. The only additional precaution which is necessary to be taken is that the mold should be thoroughly well ventilated, and also that it should have a large gate and high riser. These points cannot be too strenuously insisted upon. The object of the large gate and high riser is to allow the metal to flow in and supply the shrinkage, as the aluminum in the body of the mold shrinks, and it is very much more necessary to have large risers in the use of sand molds than it is in the use of hot iron molds, where only small gates are necessary. As in other castings, of course the finer the sand that is used in making the molds the more perfect the surface of the casting. The metal should be poured as cold as possible in order to insure sound castings, free from blow-holes (caused by the very great absorption of gas by overheated molten aluminum), or cracks and depressions due to shrinkage. A good method of producing sound castings in iron molds is to heat the molds to about 1,200 degrees F., or about the temperature of the molten aluminum, and cause the metal to cool from the bottom of the molds upward by a blast of cold air or other suitable means. Thus the metal in the comparatively large sinking head or riser remains molten until the casting is solidified. In this way the impurities segregate in the sinking head and the shrinkage is replaced with fresh additions of molten metal.

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11. C. G. B.—Can you give me information as to the carrying capacity of ball and roller bearings? As far as I can find, this information is not accessible, except such as is given in catalogues of manufacturers where I think the capacity of such bearings is overrated.

A.—In the November (1898) number of MACHINERY Prof. C. H. Benjamin contributed an article upon ball bearings in which he gave results of tests and directions for the design of such bearings. He also has given similar information in his excellent treatise upon machine design, which is published by Charles H. Holmes, Cleveland, O. The carrying capacity of ball bearings is generally calculated as some factor of the strength of the balls. This is not a satisfactory method, but may be as good as we have, with our present knowledge of the subject. The strength of steel balls varies greatly with different grades of steel. Values for breaking strength have been selected from the tables referred to, however, as follows:

For $1\frac{1}{4}$-inch hardened steel balls, 6,000 pounds per ball; $\frac{3}{8}$-inch, 18,000 pounds; $\frac{1}{2}$-inch, 30,000 pounds; $\frac{5}{8}$-inch, 42,000 pounds; $\frac{3}{4}$-inch, 54,000 pounds; 1-inch, 77,000 pounds.

In the Journal of Worcester Polytechnic Institute, Vol. 1899, Alton L. Smith says: The rule of loading balls to 1-5 of their breaking capacity is far from being approximate. If held between two parallel surfaces less than 1-10 of their breaking load would be a nearer approximation for safety. If, however, the ball rolled in V-grooves so as to have four points of contact, a higher load could be carried. The surface resistance of a small ball of $\frac{1}{4}$ or $\frac{1}{2}$-inch diameter is probably as great as that of a 1-inch ball, in which case it might safely carry the same load as the large one if this were within the elastic limit. The safe load should not be based on the breaking strength but on that load within the elastic limit which will mark its surface, when in contact with a hardened flat plate. In his book on machine design Prof. Benjamin states that ball bearings should not be called upon to sustain nearly as great a load as 1-10 of the breaking strength of the ball, as stated above. He says that experiments he has made show that a $\frac{1}{4}$-inch ball loses all value as a transmission element, on account of distortion, at any load of more than 100 pounds. He also quotes Prof. Gray, who places this figure at 40 pounds only, for $\frac{3}{8}$-inch balls; also see Machine Design, Vol. II., by Prof. F. R. Jones.

We know of no information upon roller bearings, excepting such as was obtained by tests upon the Hyatt roller bearings by a committee from the Franklin Institute. This information can doubtless be secured from the manufacturers of this style of bearings, the Hyatt Roller Bearing Co., Harrison, N. J.

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Pure gold has the unique property of welding at ordinary temperatures. It must, however, be absolutely pure and clean, and must be annealed just previous to using. When in the thin leaf state mere hand pressure is sufficient to get an intimate cohesion, although dentists generally use light percussive tools when using gold for filling teeth

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

SIXTY-INCH ROLL TURNING LATHE.

A 60-inch motor-driven roll turning lathe has been built by the American Tool Works Company, Cincinnati. In view of the severe duty for which the lathe is intended, it is built exceptionally heavy. The lathe is driven by a 25 horse-power variable speed motor, which is mounted on a substantial plates. The range of speeds thus obtained through both the headstock and the motor is very wide, varying by minute gradations.

Below the headstock, on the head end of the bed, is located the geared feed changing device. Through the three levers shown at the front of the box, seven positive feeds are

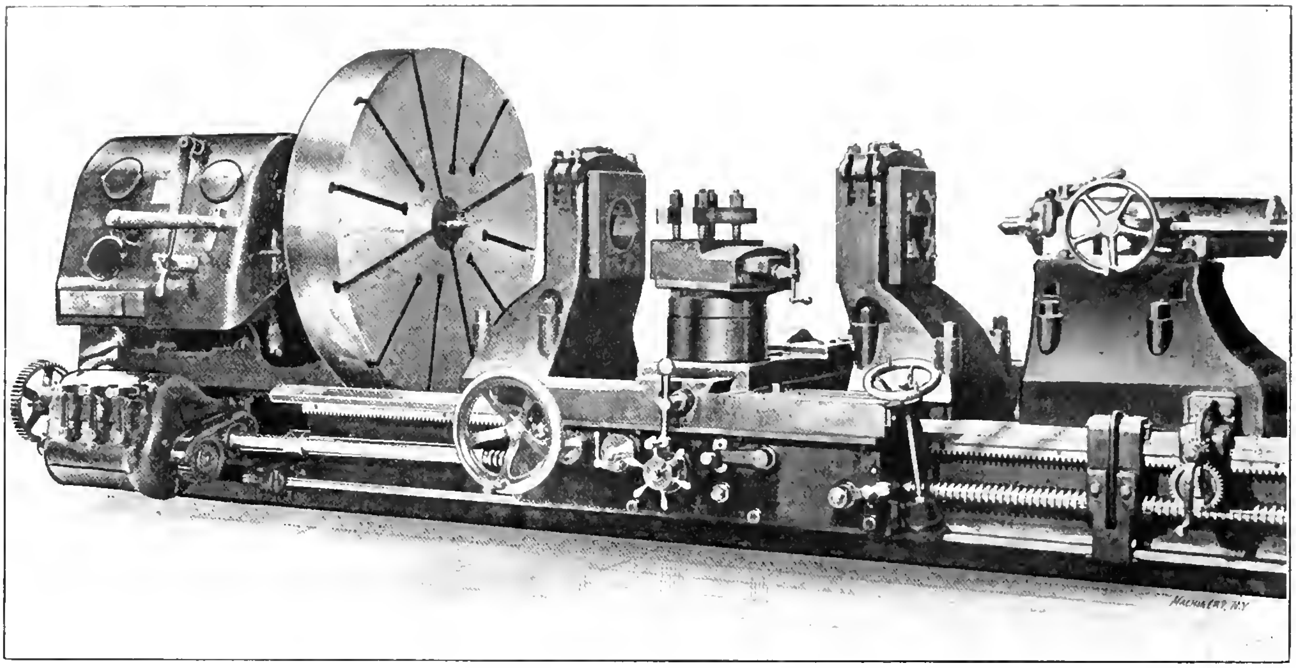


Fig. 1 American Tool Works Company's Sixty-inch Roll Turning Lathe.

stand at the rear of the headstock and is connected to the driving shaft in the headstock by silent chain, as shown in Fig. 2. Primary speed variation is obtained electrically, through manipulation of the hand wheel at the right-hand end of carriage, which starts, stops and reverses the machine, and also varies the speed by minute increments. These electrical changes are supplemented by mechanical changes obtained through the all-gear headstock, by means of the two levers

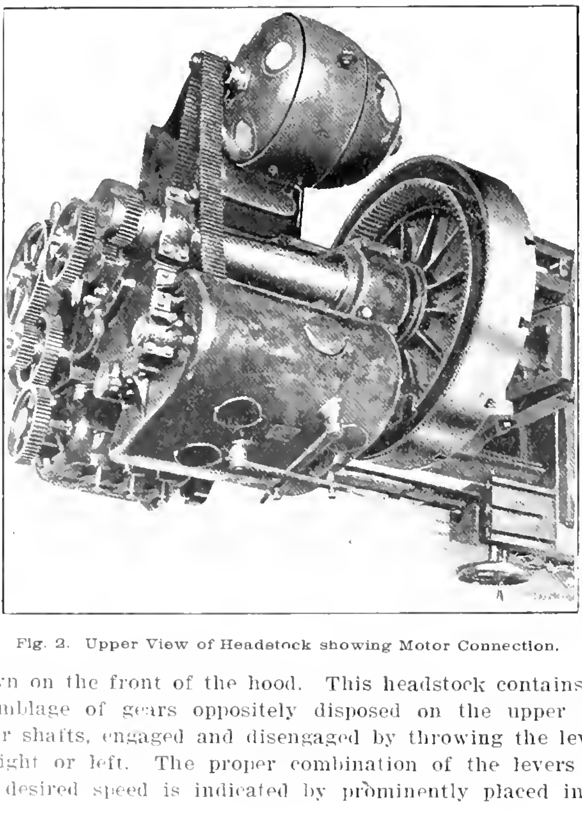


Fig. 2. Upper View of Headstock showing Motor Connection.

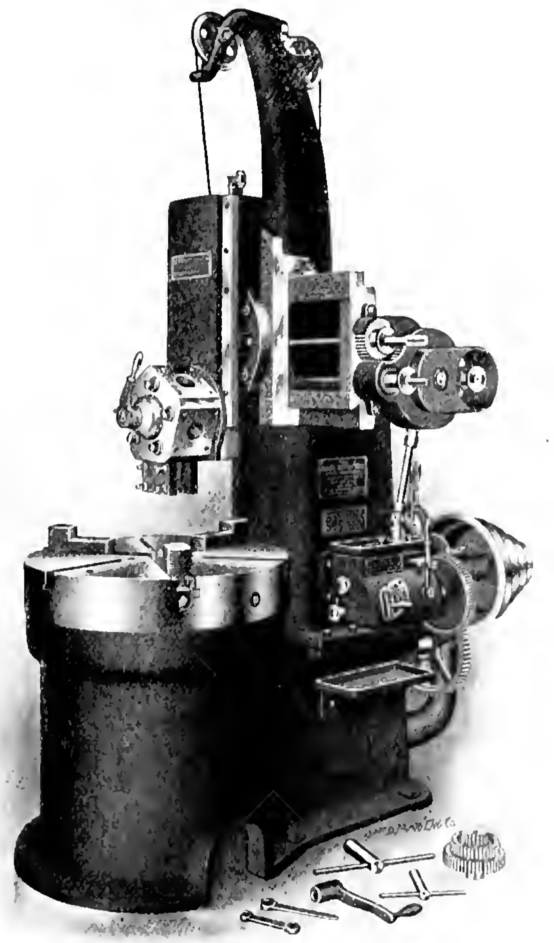
shown on the front of the hood. This headstock contains an assemblage of gears oppositely disposed on the upper and lower shafts, engaged and disengaged by throwing the levers to right or left. The proper combination of the levers for any desired speed is indicated by prominently placed index obtainable, without removing a single gear. The gears are mounted on two shafts and are completely housed in. Simple index plates show clearly the various combinations for obtaining any desired thread, pitch or feed.

Aside from the motor drive, the features of especial interest on this particular lathe are the roll turning attachments. The heavy housings are for the purpose of holding pipe roll castings. At the rear of the machine, mounted on the rear of the bed is a roll forming attachment, the purpose of which is to impart curved surfaces to long pipe straightening rolls. It operates on the principle of a taper attachment. A shoe, provided with anti-friction rollers, slides in a trough following master bars, thus generating the same curve on the rolls being turned. Straight work can be turned by simply disengaging the nut which holds the shoe, and by tightening the cross-feed nut. A concaving rest for semi-circular grooves is interchangeable with the compound rest, and is used for grooving out pipe welding rolls, with a capacity for rolls for pipe from 2 to 20 inches diameter, a limiting gage being provided for setting the tool to any desired diameter. This rest operates with rotary motion, through a worm and worm wheel, with either hand or power feed, the latter being derived through the feed rod and carriage with all the advantages of the regular feeds.

THIRTY-INCH BORING AND TURNING MILL.

The boring and turning mill illustrated herewith has just been placed on the market by the Baush Machine Tool Co., Springfield, Mass. It is built with a swivel turret head and swings 32 inches in diameter and 15 inches under the cross rail. The chuck or faceplate has eight changes of speed. It is bolted to a large driving gear which has an outer bearing with automatic oiling device arranged in the bed so as to keep the bearings well lubricated. The center spindle is 7 inches in diameter and 18 inches in length, and is made with angular bearing to receive side strains, with check nuts on the under side of the spindle to prevent any lifting tendency. The turret has five sides—10 inches across the flats—and five 2 3-16-inch

holes. The turret slide has a traverse of 16 inches and in the swivel head can be set over at any angle up to 30 degrees, and will face 30 inches diameter. The vertical feeds have 20 changes, and the horizontal feeds also 20 changes. A cone of large diameter, having a 3-inch belt, drives this mill, but it can be equipped with motor drive at any time. Back gears can be changed by means of a lever without the use of a lock-nut.



Baush Boring and Turning Mill.

The machine is self-contained and does not require an expensive foundation. On the upright of this mill is a Hendey-Norton change gear device for feeding and thread cutting. Threads from 5 to 20 to the inch can be cut. The mill weighs 5,900 pounds.

LUTZ ADJUSTABLE SCRAPER HOLDER.

The cut shows a convenient scraper holder made by the Lutz Tool Company, Springfield, Ohio. It is adjustable, which feature makes it convenient for finishing flat, grooved, curved or angular surfaces, and for getting down to the faces of small valve seats, for instance, which, in some designs of engines and pumps, are inaccessible to ordinary scrapers save when they are bent to an angle. The Lutz scraper can be instantly

Adjustable Scraper Holder.

adjusted and securely locked at any required angle. It holds any size blade up to 2½ inches, and the blades can be quickly changed for others when special shapes are required, etc. The holder is a steel drop forging, well finished, making a handsome and durable tool that should be highly prized by mechanics who have much close and accurate fitting to do.

SHAPER FOR HEAVY WORK.

The cuts herewith show the "Queen City" 16-inch crank shaper especially designed for heavy duty and durability. The column is large and very heavy, and is reinforced where necessary to resist working strain. The design of the ram is original. The arch construction brings the maximum section of metal into service at the point where leverage is greatest, that is, when the cutting tool is at its extreme forward position. The bearing for the ram is 30¼ x 10 inches, and the slides for same overhang, thus giving the tool increased stiffness. The position of ram and the length of stroke can be changed without leaving the work and while the tool is in motion or at rest.

The rail, too, is very heavy; the cross traverse is 21 inches and the screw has a graduated collar. A vertical adjustment can be obtained by the use of bevel gears provided with ball bearings.

The rocker arm is connected to the ram by means of a link which gives a straight pull, an even cutting speed, with quick return and no lost motion. Fig. 2, on the next page, shows this construction, and also the excellent adjustment to compensate for wear of the crank shoe. The table has a V for holding shafts and similar work vertically, and can be readily detached from the saddle. An extension provides for a broad clamping surface, and the manufacturers, the Queen City Mch. Tool Co., Cincinnati, O., will furnish an outer support if desired.

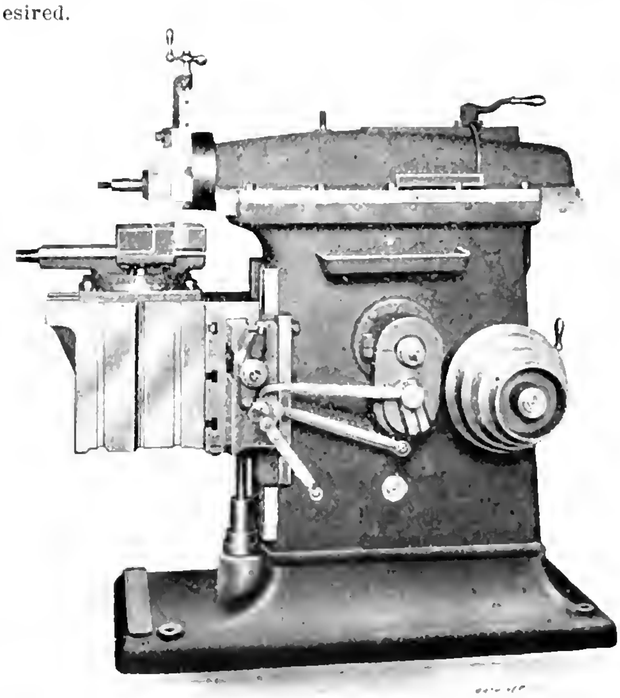


Fig. 1. Shaper for Heavy Work.

The vise is of the planer type and is stiff enough to hold the work solid even on angle cuts. The flat wearing surfaces are scraped to a standard surface plate and are very wide. All extra attachments, such as power down feed, concave attachments, tilting and removing table, etc., are furnished when required.

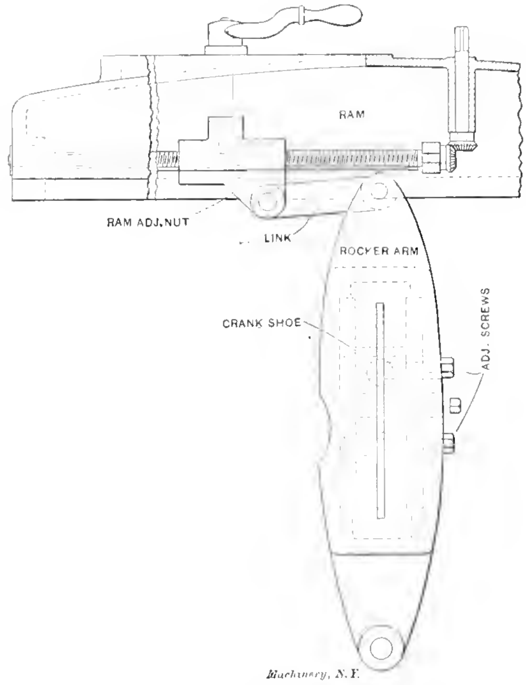
THE GORHAM HEATING FURNACE.

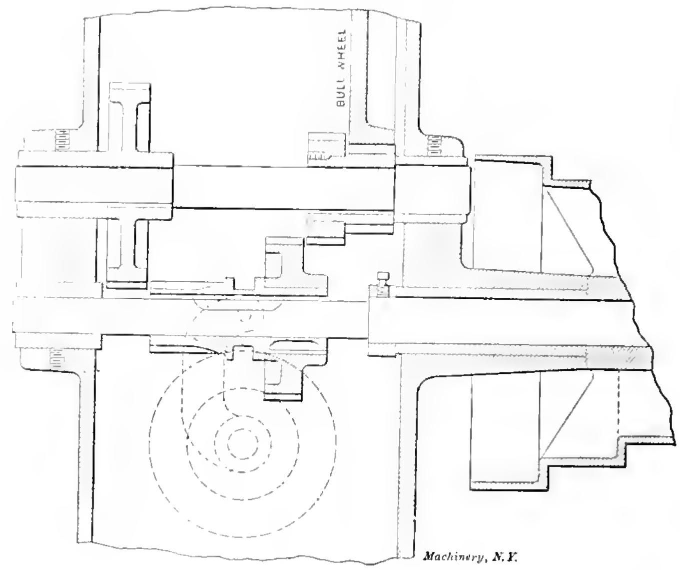
The cut herewith is of the "Gorham" revolving forge furnace now being built and sold by the National Machinery Co., Tiffin, O. This is an oil or gas-burning furnace, and is especially suitable for use in connection with bolt headers, or forging machines, for heating bolt blanks, wheel spokes and similar forgings.

The design of this furnace is such that its four sides are used as heating surfaces. The furnace proper turns on a ball bearing base, and is revolved by the attendant with extreme ease. This arrangement requires but little floor space, and as only one side of the furnace faces the operator the heat radiated upon him is slight. There is a large economy of fuel in comparison with a horizontal furnace of equal capacity, as the irons to be heated are in the most advantageous place, i. e., where the hot gases concentrate, and where the heat is most intense. Furthermore, the heating effect is uniform, as

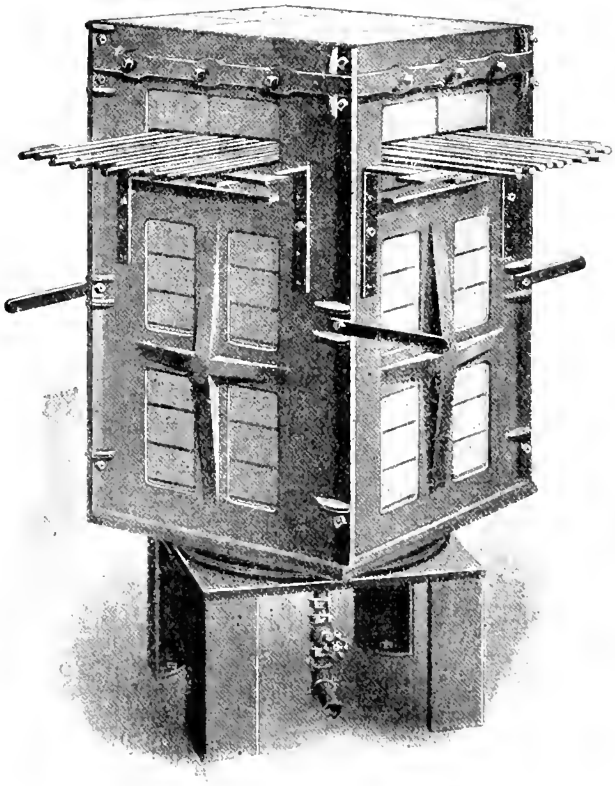
the irons are practically equidistant from the burner, and will heat at the same rate of speed. The lining and also the top of the furnace are made of commercial size 9-inch fire brick, and no especially molded tile is required. Either low or high-pressure burners are used; one requiring an air blast of about eight ounces per square inch, and the other a blast of fifteen pounds or more per square inch. The latter is recommended as being the most convenient and economical. The burner is attached to the base of the furnace, and is vertical and stationary, and requires no swivel joints. The spray of air and oil passes from the burner through a flue at the bottom of the chamber, strikes against a baffle brick and ignites after passing it. As stated above, the heating chamber is vertical and revolving, and although a few vent holes are provided upon the top, a chimney is unnecessary, as the combustion is practically perfect, and the escape of gas is slight. The openings in the top of the sides of the heating chamber are to be partially bricked in, leaving suitable slo s to receive the irons to be heated. Suitable lighting and slag holes are provided, and the internal arrangements prevent slag from flowing into and clogging the burner flue.

The approximate output per hour is four hundred 1-inch, seven hundred ¾-inch or one thousand ½-inch blanks heated three diameters in length. The net weight of this machine complete with lining is 1,400 pounds. The floor space occupied is 21 x 21 inches, and the height is 4 feet.





Figs. 2 and 3. Details of Ram, Rocker Arm and Back Gears of the Queen City Sixteen-inch Crank Shaper.



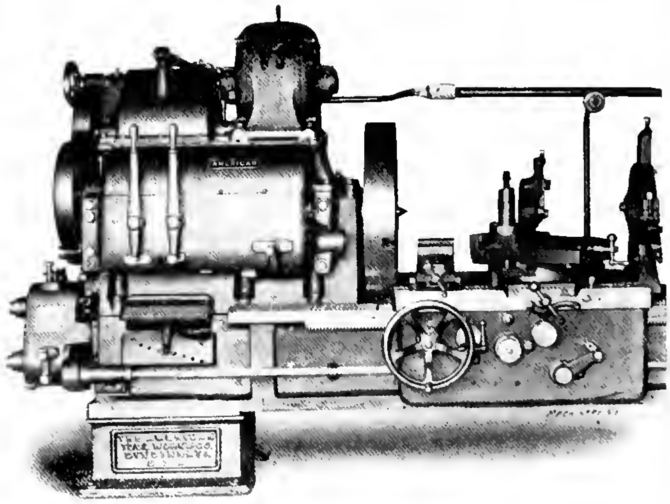
The Gorham Revolving Furnace.

THIRTY-INCH AMERICAN ENGINE LATHE.

The cut herewith shows a 30-inch engine lathe equipped with an interesting method of motor drive, and built by the American Tool Works Co., Cincinnati, O. The drive is designed for a constant-speed motor, either direct or alternating current. The various spindle speeds are obtained mechanically through the gear-driven headstock, the mechanism of which consists of a patent clutch and gear arrangement employing the minimum number of gears and shafts for such a device.

Through manipulation of the levers at the front of the head, and the one at the lower right corner of the head, sixteen distinct and positive speeds to the spindle are provided, in geometrical progression, ranging from 3.8 to 246. Thus a wide range is obtained entirely through mechanical means, sufficient to cover the ordinary work of this lathe. As the construction is simple, all gears and shafts can be made of large diameters. The whole is neatly incased, and all parts are accessible for lubrication.

A non-reversible constant speed motor may be used if desired, because the reverse is obtained mechanically, by means of the rod shown mounted above the lathe, out of the way,



Thirty-inch Engine Lathe, American Tool Works Company.

yet convenient to the operator. The good feature of this construction is that the motor is at no time reversed, but runs at continuous constant speed, all starting, stopping and reversing of the machine being accomplished without interference with the motor.

The motor is substantially mounted above the all-gear headstock, and the lathe may be at any time converted into a belt-driven machine by replacing the motor by a single pulley mounted on the upper shaft.

SPECIAL HIGH-SPEED LATHE.

The lathe shown in the cut, Fig. 1, has recently been designed by P. Blaisdell & Co., Worcester, Mass., to meet the demand for a powerful tool, with a wide range of geared speeds, created by the increasing use of high speed steels. With two ratios of back gearing, 3½ and 12 to 1, and the three-speed countershaft, 27 spindle speeds are obtainable, 18 of which are geared. There are 90 positive feeds ranging from 8 to 288. The feed mechanism is shown, in detail, in Fig. 2. The change of feed is effected by the lateral movement of a rod which slides in the hollow shaft that carries the lower cone of gears. This rod, which is actuated by the lever at the right-hand side of the feed box, is fitted with a spring feather-key, which is hinged at one end of the slot milled to receive it. The projection on the free end of this key has a bevel on either side of it, so that when being shifted from one gear to another, it is depressed flush with the shaft and snaps into the keyway in the gear as soon as that matches with it. This is a novel form of feather-key and gives a simple and strong construction, free from the jolt and wear that are so objectionable in the usual form of sliding feather-key. The feeds are reversed from the carriage by means of the lever at the right of the apron in Fig. 1. This motion imparted by this lever to the lower one of the two shafts on the front of the lathe, is transmitted, through the arm on the opposite end of this shaft, to the reversing gear, which is contained within the headstock. The carriage is fitted with a graduated, compound rest, and the power cross and angular feeds have graduated adjustment.

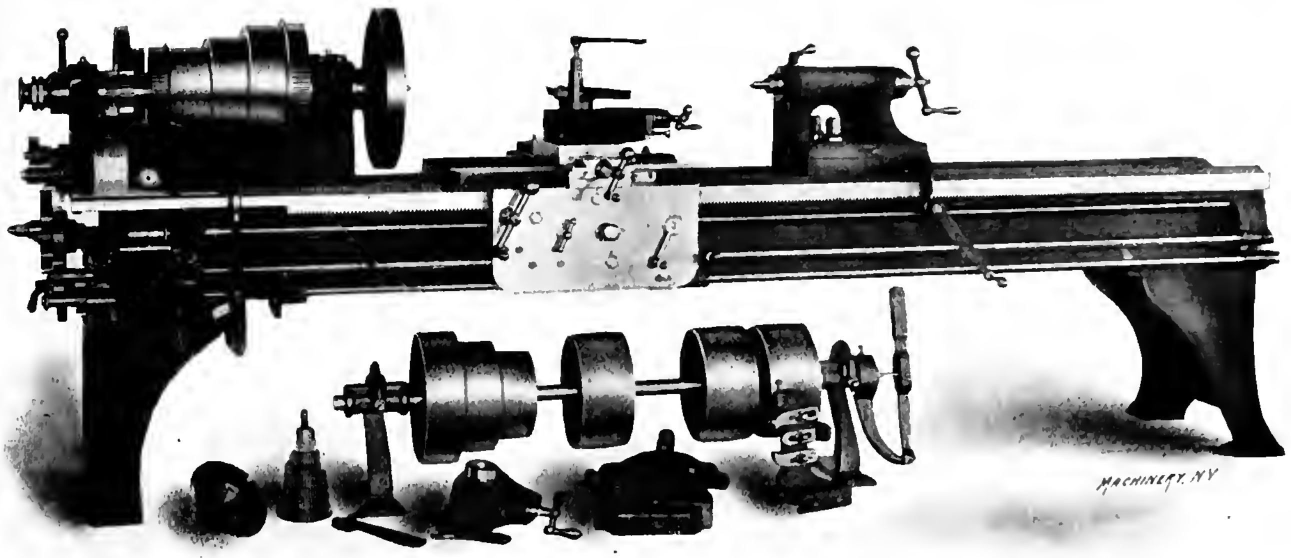


Fig. 1. High-speed Blaisdell Lathe.

The lathe shown in the half-tone swings 22 inches clear of the shears. The front spindle bearing is 3½ inches in diameter by 5½ inches long, and the hole through the spindle

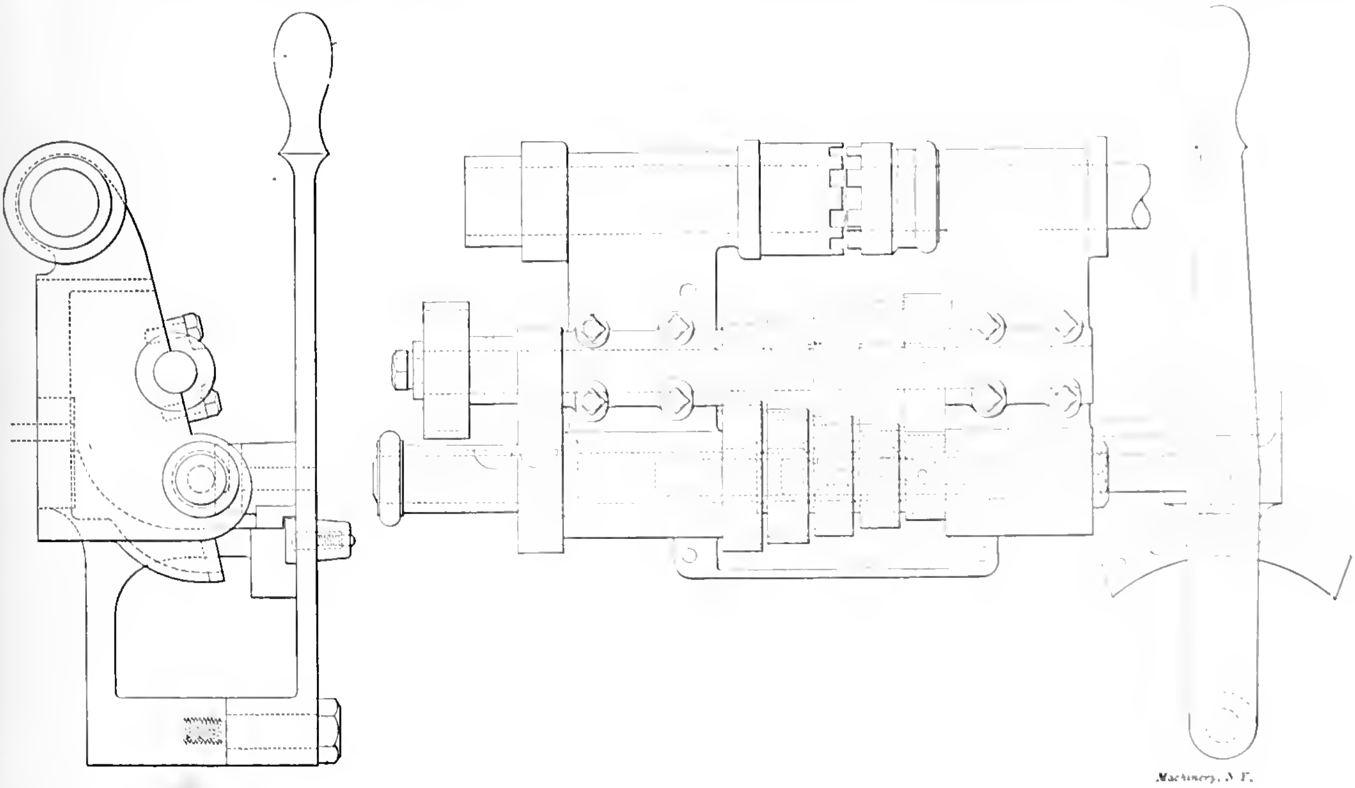
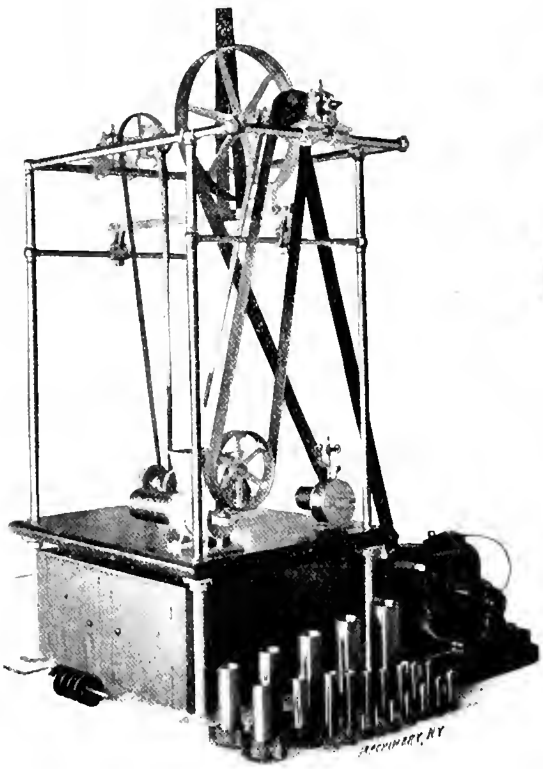


Fig. 2. Details of Feed Mechanism.

1 7-16 inches in diameter. The cone steps are: 9¼ inches; 11⅝ inches and 14 inches by 3⅞ inches face. The tail-stock spindle has a diameter of 2⅜ inches. A pulley-turning attachment is furnished, if desired, and it is claimed for this machine that it will turn out 100 pulleys, 12 x 5 inches, in 10 hours. In manufacturing shops, particularly, where heavy cuts and cross feeds are the rule, the lathe will be favorably received.

CORE-MAKING MACHINE.

A machine for making cores, the invention of Mr. G. H. Wadsworth, and now being built for the market by the Falls Rivet and Machine Co., Cuyahoga Falls, O., is shown in the accompanying illustration. The vital principal of this machine is new only as applied to the making of cores, being simply the screw, or helical conveyor, such as is used in the sausage mill and in some brick machines. Mr. Wadsworth's machine, however, has many features to recommend it to foundrymen. It will make properly vented cores, of uniform density in round, square, hexagon, oblong, T-shaped, or in fact, in any shape for which the proper dies are made. The cores produced by this machine are very smooth and do not require blackening or slicking, and as they can be made in long lengths, there is a saving in oven room. The range of work produced by the machine embraces 24 sizes of perfectly round cores, ranging from ⅜ inches to 6 inches in diameter, and almost any length desired; 6 inch cores having been made 10 feet 6 inches long. The venting is done by a stationary rod, which passes through a hole in the center of the shaft which carries the screw. Contrary to expectation the wear on this venting rod and on the disks is so slight as to be hardly noticeable. The cores are coned at the ends by being held against an emery wheel at the proper angle, in a device similar to that used in the twist drill grinder.



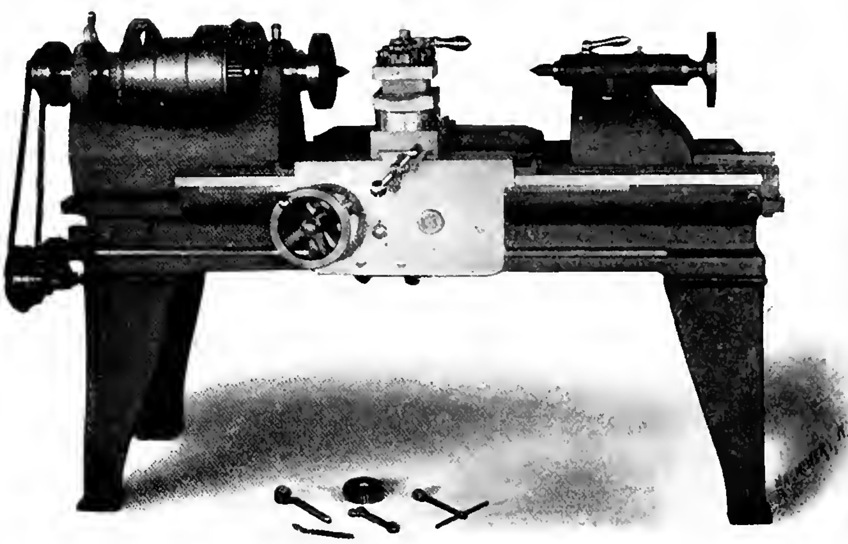
Wadeworth Core-making Machine.

We are informed that upon a basis of an expenditure of 10 cents for wages and a production of from 200 to 600 feet of core per hour, the Wadsworth machine will make from 20 to 60 feet of finished core for one cent.

ACCURATE TAPER TURNING LATHE.

A lathe for turning positive tapers on work of different lengths, without resetting, has recently been put on the market by Fay & Scott, Dexter, Me. The head and tail-stocks of this lathe are fitted to a swivel plate, which is contained within and is independent of the sheaves upon which the tool carriage travels. As the lathe centers always remain in line, and the tool carriage travels perfectly free, without the interference of the usual taper attachment, the work turned out by this machine is very accurate. A point which will, no doubt, make the tool popular with the men in the shop is the absence of back lash in the slide rest, and the consequent trouble in adjusting the tool to turn the size desired, as is the case when lathes are fitted with the usual taper attachment. The carriage is fitted with an automatic stop motion for throwing out the feed, allowing the carriage to be run back without loosening any friction device. This lathe is well adapted to toolroom use, where accuracy in turning taper reamers and taps is essential.

The accompanying illustration is from a photograph of an 18-inch lathe of this pattern. The swivel plate projects beyond the shears at the tail of the lathe. The principal specifications are: Ratio of back gearing, 11 to 1; swing over bed, 18½ inches; swing over carriage, 12 inches: cone diameter, 5 to 10 inches; width of steps on cone 3⅞ inches; hole through spindle, 1⅜ inches; front bearing of spindle, 2 11-16 inches diameter by 5 1-16 inches long; diameter of tail stock spindle, 1⅞ inches, and with a 6-foot bed it will take 30 inches between the centers. The spindles are chucked for Morse taper No. 4.

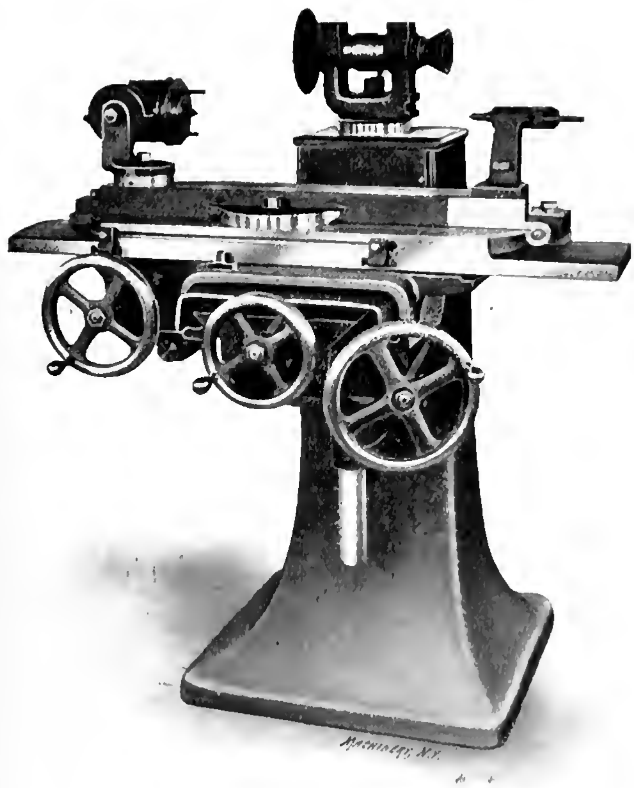


Fay & Scott Taper-turning Lathe.

UNIVERSAL CUTTER GRINDER.

The half-tone herewith shows a newly-designed universal cutter and tool grinder which will grind all work within its range to a great degree of accuracy. Taking the fact into consideration that a grinder must be absolutely rigid and free from vibration if it is to do accurate work, special attention was given in designing this machine to attain this end. The column, as well as knee, saddle, slide and table, are of box form with internal braces. The wheel spindle frame can be swiveled 180 degrees; the base is graduated and locked in any position, it is dust-proof and can be adjusted to compensate for wear. All the bearings, slides and screws are covered. The adjusting hand wheels are of large size and are graduated on the outside, reading to a thousandth. The table is swiveled on a central stud and clamped in any position, has graduated arc in front, reading to degrees, and there is a scale on the slide which reads to 3-inch taper per foot either way. One end of the table is formed to a wormwheel, into which engages a worm by means of which the table can be readily adjusted either way to the desired taper.

For all operations there is but one tooth rest used; it has a micrometer adjustment and can be set in any position. The dimensions of the machine are: Table movement, longitudinal, 15 inches; cross movement, 8 inches; vertical movement, 7 inches; swings between centers, 9 inches, with raising blocks 12 inches by 20 inches long; grinds 16-inch face mills, 36-inch saws. Many operations can be done on this grinder for which other grinders require special attachments such as grinding gear cutters, face of teeth in taps, formed cutters, hobs, etc.



Oesterlein Cutter Grinder.

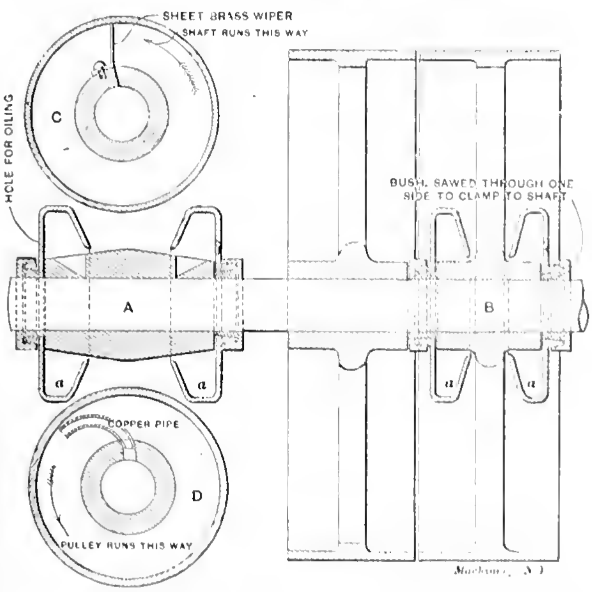
With this machine is furnished a 3-inch chuck, swivel vise, main and drum countershaft and a set of grinding wheels.

It is being built by the Oesterlein Machine Co., Cincinnati, O.

THE ALLMOND OIL CUP.

A type of oil cup is illustrated herewith which has been applied successfully to the loose pulleys of countershafts and the main bearings of countershafts, line shafts, etc. It is manufactured by Charles H. Allmond, 804 First avenue, So., Seattle, Wash.

At *A* in the illustration is shown the oil cup as applied to a stationary bearing, and at *B* as applied to a loose pulley. In both cases the cups which retain the oil are secured to the shaft by a clamp bushing, the construction of which will be

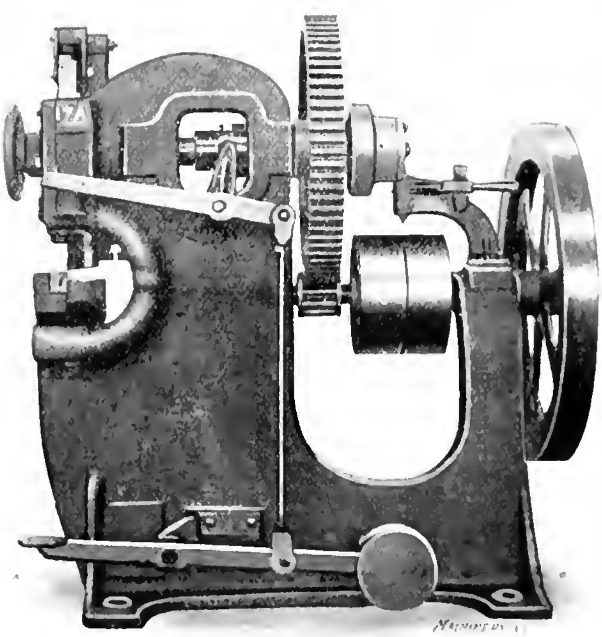


Allmond Oil Cup.

evident from the sketch. The part of the bushing that fits the shaft is split, and, by screwing the two threaded portions together, the outer part of the cup is drawn over the inner taper bushing which securely clamps the latter to the shaft. When the shaft is stationary the oil simply remains in the lower part of the cup at *a a*. When the shaft rotates, the oil is thrown out by centrifugal force to the outer periphery of the cup where it would remain except that it is impeded in its motion by a suitable wiper which carries it back to the bearing. The kind of wiper that is used depends upon whether the cup is applied to a stationary bearing or to a loose pulley. In the former case the construction shown at *C* is used. Here the oil, as it revolves with the cup, is caught by the piece of sheet brass and caused to flow inward to the bearing. At *B* and *D* are shown the construction for the loose pulley. When the loose pulley is running the cup is stationary and the oil remains at the bottom. A bent copper pipe inserted in the hub of the loose pulley, however, scoops part of the oil at each rotation of the pulley and carries it to the shaft. Mr. Allmond writes that the countershaft illustrated in the sketch is one applied to woodworking machinery, and that it has run 16 days with one oiling and that there is no drip or spatter of the oil. He has also applied the cups to the top wheel and loose pulleys of band saws. Another instance is on a line shaft running 550 revolutions. With cast iron boxes it was found that the shaft runs without heating. Mr. Allmond has a shop fitted throughout with the oil cups, which, he writes, require attention but once a week and give entire satisfaction.

NEW T-IRON NOTCHING TOOL.

The accompanying cut illustrates a tool which will prove of interest to any one requiring T or angle iron with leg notched or cut away flush with the remaining leg. The knives are so arranged that the leg can be cut away either at the end or at any point in length of the bar, and length of cut can be varied

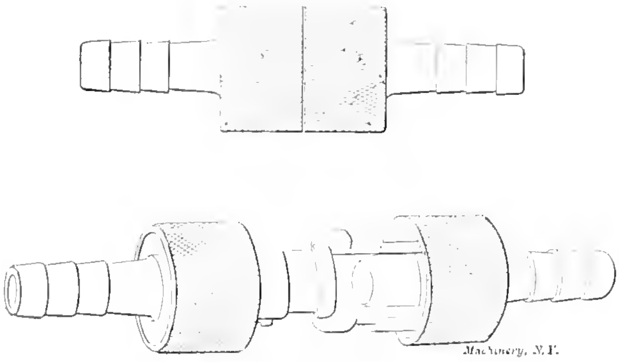


to suit requirements. The side knives are so arranged that either a straight or angular cut can be made on the leg being notched.

For work of this kind the makers claim it to be a very efficient and labor-saving tool. This machine was recently built by the New Doty Mfg. Co., Janesville, Wis.

AIR HOSE COUPLING.

A simple, strong and quick-acting hose coupling, for use in connection with pneumatic tools, known as the "Giv't-a-twist" air hose coupling has recently been placed on the market by the Ingersoll-Sergeant Drill Co., 26 Cortlandt Street, New York. As will be seen from the sketch, no wrench or spanner is required to either couple or uncouple the parts. To make a coupling it is only necessary to push the halves together by hand and slightly twist the locking rings in opposite directions. To uncouple, the operation is reversed. Both halves of the coupling being identically the same, the usual necessity of mating the ends is obviated. There are no projections to catch or break off by the hose being dragged from place to place. The rubber sleeve is entirely encased when the coupling is made, and will withstand any working pressure without leakage. The parts are made of brass, extra heavy, to stand rough usage, and are machined throughout.

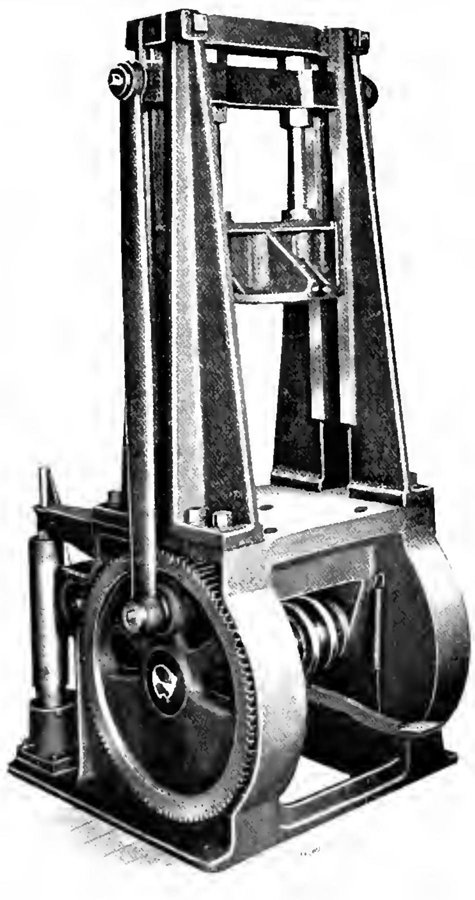


The Giv't-a-Twist Air Hose Coupling

This coupling is manufactured in all standard sizes for connection: Hose to hose, hose to pipe, or pipe to pipe with male and female shanks.

NEW WIRING PRESS.

The illustration herewith is of a wiring press recently completed by the E. W. Bliss Co., Brooklyn, N. Y. It was designed to obviate the slow and laborious handling of large and heavy dies. The stroke of slide is sufficiently long to raise the punch high enough to permit of insertion in the die of the article to be wired, or its removal, without disturbing the die. A good



Wiring Press, E. W Bliss Company.

operator can catch every stroke of the press. The slide plate generally used on a wiring press for moving the die back and forth to insert or remove the article to be wired is not used on this press; the long stroke makes it unnecessary to handle the die. This saves much time and labor and increases considerably the output of the machine.

The press is provided with a powerful friction clutch and the slide is counterweighted. The principal dimensions are: Weight, 3,600 pounds; it will wire up to (diameter and depth) 15 x 12 inches; distance from bed to slide, stroke down and adjustment up, 16 inches; distance between gibs, 20 inches.

* * *

FRESH FROM THE PRESS.

ANNUAL OFFICIAL DIRECTORY OF THE TEXTILE INDUSTRIES AND THE YARN TRADE. 1904 Edition. Published by the Lord & Nagle Co., 299 Devonshire St., Boston, Mass. Bound in cloth. Standard size, 6x9. 528 pages. Price Travelers' edition, $2.00; office edition, larger size, $2.50.

This work is divided into five parts, as follows: Part I., Textile Manufacturers; Part II., the Yarn Trade Index; Part III., Classified Lists of Commission and Order Mills, Dyeing Establishments; Part IV., Dealers in Raw Materials and Stock; Part V., Agents and Buyers of Textile Fabrics. Very full information is given on the subjects included under these various headings, and about 20 textile maps, showing the location of cities and towns where there are textile industries are to be found. The work has been thoroughly revised and brought up to date.

DIRECTORY TO THE IRON AND STEEL WORKS OF THE UNITED STATES. Sixteenth edition, 1904. Published by the Iron and Steel Association, 261 South Fourth street, Philadelphia, Pa. Bound in cloth. 468 pages. Corrected to August 1, 1904. Price, $10.00.

This book, which is compiled and published by the above named company, embraces a full description of the blast furnaces, rolling mills, steel works, tin plate and terne plate works, and forges and bloomaries in the United States. Also classified lists of the wire rod mills, the structural mills, plate sheet and skelp mills, black plate mills, rail mills, steel casting works, Bessemer steel works, openhearth steel works and crucible steel works. This has been thoroughly revised and brought up to date and the publishers call attention in the preface to the fact that inquiries submitted to manufacturers were even more searching and more comprehensive than for previous editions, so that the information on the above-mentioned subjects is complete and reliable. A very full table of contents and complete index are also to be found in this edition.

FORGE PRACTICE. By John L. Bacon, Instructor of Forge Work, Lewis Institute, Chicago, Ill. 257 pages, 4¾x7¼ inches, and 272 cuts. Published by John Wiley & Sons, New York. Price $1.50.

Although this work is dubbed an elementary one by the author, being the outgrowth of a series of notes given to the students of Lewis Institute on forge work, it is eminently practical and contains much that should be helpful to the working smith. The text is free from padding and is right to the point, being expressed in language remarkably clear and easy to comprehend. Following a general description of the forge and tools is a chapter on welding, and then in order are chapters on calculation of stock for bent shapes; upsetting, drawing out and bending; simple forged work; calculation of stock, and making general forgings; steam hammer work; duplicate work, metallurgy of iron and steel; tool steel work; tool forging and tempering, etc. The sketches are well drawn, many of them being in perspective which is best for illustrating work of this character. The book is one that should be popular in trade schools and similar institutions giving instructions in practical forge work.

BEVEL GEAR TABLES, by D. Ag. Engstrom. 66 pages, 5½x7¼ inches with eight cuts. Published by the Derry-Collard Co., 256 Broadway, New York. Price, $1.00.

This little book is not a treatise on bevel gears, but is intended to help the practical man who has little knowledge of trigonometry, or who is too busy to resort to the calculations involved. In the preliminary explanation of the terms and use of the tables a very clear conception of the elements of bevel gears is conveyed to the reader. The tables are successively calculated for gears of 12 to 47 teeth, inclusive, mating with gears of 12 to 47 teeth, inclusive, thus making thirty-six tables in all. These tables give without calculation the outside diameter, placing distance, outside cone radius, face angle, edge angle, cutting angle and number of cutter, all for a diametral pitch of 1. Other diametral pitches are simply obtained by dividing the given distances by the required pitch, the angles, of course, remaining the same. For circular pitch, the values in the tables are multiplied by the "diameter" pitch which is the reciprocal of diametral pitch, and a table of diameter pitches is given for circular pitches from 1 1-16 to 3 inches, inclusive.

AIR BRAKE TESTS, compiled by the Westinghouse Air Brake Company. 323 pages, 4½ x 7 inches, and 130 cuts. Bound in limp leather. Published by the Company at Wilmerding, Pa.

This book is a compilation of the principal tests of air brakes that have been made in this country and abroad to determine the factors that affect braking efficiency. The opening chapter is a brief resume of the history of braking, leading up to the introduction of the "Straight-air" brake by Mr. George Westinghouse in 1869, which was the forerunner of the automatic air brake now in general use on railway trains throughout the world. Then follow the three papers read by Capt. Douglas Galton before the Institution of Mechanical Engineers, describing the now historic Galton-Westinghouse air brake trials made in England in 1878-79, on the London, Brighton and South Coast Railway, and the North Eastern Railway. The Paris and Orleans Railway tests were made in 1879, and following the description of these is that of the Burlington brake trials in 1886-87, which are treated at length, 116 pages being given over to these famous tests. Then follow the Westinghouse freight train tests, made in 1887; the Karner tests on the New York Central, in 1892; the Sang Hollow tests on the Pennsylvania Railroad, in 1900; the Shiproad tests on the same railway in 1894; the Nashville locomotive tests; the Absecon tests; and the Atsion tests. The book is one that will interest the advanced air brake man and the mechanical engineer.

MACHINE DESIGN, by Charles Lewis Griffin, S.B. Published by the author, Syracuse, N. Y. 183 8-vo pages. Illustrated. Price $1.50.

Mr. Griffin is experienced as an instructor in machine design, but has recently again taken up engineering work along commercial lines. The matter in this book is the result of his experience both in designing machinery and in teaching. It comprises matter that he has proposed to publish for the benefit of his students, but which he has not had an opportunity to publish until recently. It is practically the same as was prepared by him for the use of the American School of Correspondence, Chicago, and which we have already referred to in these columus.

The book is along strictly original lines and its distinguishing characteristic is that it teaches the method of designing rather than giving a great quantity of data and leaving the student in the dark as to the method of applying the data. It takes up, in the first place, the design of a simple but complete machine and shows how the draftsman would go to work to gather his data, make preliminary calculations, lay out the work on the sheet, and finally detail the work to the draftsman under him for making the finished drawings. This whole process is worked out clearly by means of freehand and finished sketches, calculations as they would be made by the draftsman in his notebook, etc. In the second part of the volume the elements of machine design are treated, such as belts, pulleys, shafts, gears, friction clutches, bolts, keys, etc. If a student wishes to really learn how to design machinery, by home study, or if an instructor wishes to lead his students along correct paths in machine design, we think that either will find this treatise unusually well adapted for the purpose.

AMERICAN SMALL ARMS, by Edward S. Farrow, late Instructor of Tactics at the United States Military Academy, West Point, etc. 408 pages, 7x10¼ inches, and 500 cuts. Bound in green cloth with gilt top. Published by the Bradford Company, New York. Price, $5.00.

Mr. Farrow was led to the compilation of this interesting work by noting the great variety of American small arms found in the possession of a tribe of Indians which he captured some twenty-five years ago while in the U. S. Army service; and the fact that there is, or was, an almost complete absence of writings on the subject. This

MACHINERY.

November, 1904.

A REVIEW OF STEAM TURBINE PATENTS.—2.

Hoehl, Brakell & Gunther, 1863.

The turbine produced by this aggregation of inventors has as its only novelty an arrangement of passages by which the steam returns on itself and so is utilized twice by the same wheel, although an additional set of wheel blades is required.

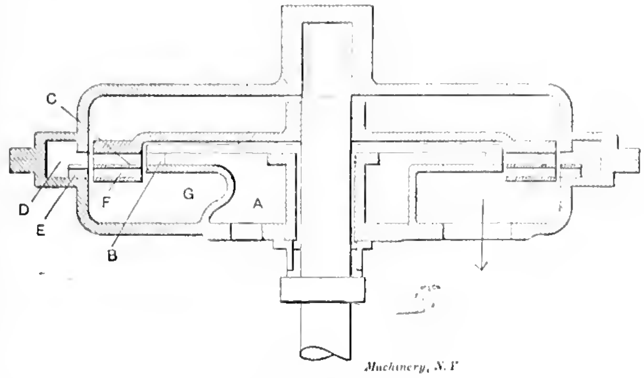


Fig. 19. Hoehl, Brakell & Gunther.

Steam enters the chamber *A*, passes radially outward through the guide passages *B* to the wheel blades *C*, then discharges into the annular chamber *D*, where its motion is reversed, and escapes through *E* to another set of buckets *F*, and finally to the exhaust chamber *G*.

Perrigault & Farcot.

The type of turbine here exemplified is in principle like Wilson's turbine, in Fig. 13 of the September number, the latest representative of which is found in the compound turbine of Messrs. Riedler and Stumpf, to which reference will be made later. The inventions of Perrigault & Farcot took several forms, but the general principle is well illustrated by Fig. 20 herewith. Here steam enters through the pipe or nozzle *A* and impinges against the wheel buckets, passing through the other side of the wheel where it discharges into pipe *B*. This pipe brings the steam around

Fig. 20. Compound Turbine with only one Wheel

again to the inlet side of the wheel, allowing it to discharge a second time against the buckets of the same wheel, when it is again picked up by a second pipe *C* and so on. The exhaust is finally through pipe *D*.

The arrangement consists essentially in a bundle of bent pipes having openings *a*, *b*, *c*, through which the steam impinges against the wheel buckets; and openings on the other side, *x*, *y*., etc., which gather up the steam flowing from the wheel and bring it round again to the inlet side. The object is to utilize the steam over and over without necessitating a series of rotating wheels. It is a system that has been tried with various modifications, but without much success. Its obvious disadvantages are: Large losses from friction and leakage, and the wide range of temperatures through which the same buckets must pass, thus causing condensation and re-evaporation as in the steam engine.

Hannsen, 1870.

Among the most successful types of turbine is that having a succession of chambers in each of which is a single impulse wheel. There is only a slight drop in pressure from chamber to chamber, so that the velocity of the steam does not become excessively high at any point. The latest turbine of this description is the Hamilton-Holzwarth, built by the Hoovens,

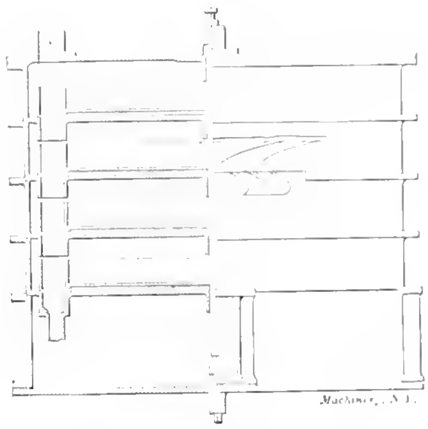


Fig. 21 Compound Impulse Turbine.

Owens, Rentschler Co., Hamilton, O., and the earliest one of which there is any record is the invention of Real & Pichon, 1827—the first patent referred to in this series. The invention of Hannsen, shown in Fig. 21, is almost precisely the same, except in regard to structural features. This is a vertical turbine, steam entering at the bottom and rising to the top.

Moorhouse, 1877.

Of far greater importance, however, is the patent of James Moorhouse for a turbine on the same plan. As shown in Fig. 22 *a*, *a*, *a*, etc., are the nozzles, and *b*, *b*, *b*, etc., the wheel buckets. Steam flows radially outward at each wheel until near the exhaust end, where there is a different arrangement owing to a smaller drop in pressure between the successive chambers.

Moorhouse realized what previous inventors of this type of

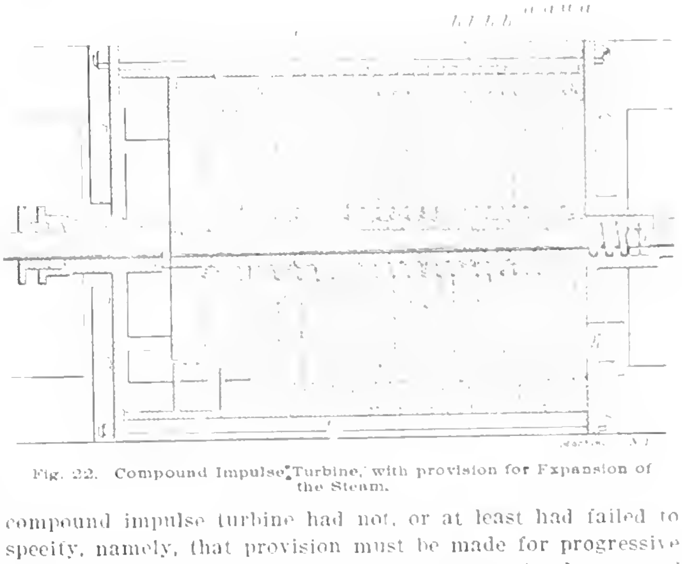


Fig. 22. Compound Impulse Turbine, with provision for Expansion of the Steam.

compound impulse turbine had not, or at least had failed to specify, namely, that provision must be made for progressive expansion of the steam by a gradual increase in the area of the steam passages. His patent is a broad one and fully covers this requirement as a general principle, apart from the

exact method used in its application. In his specifications he says that his invention consists of a cylinder built in sections, each section composing a separate compartment. Through the center of the cylinder passes a revolving driving shaft upon which is fitted a series of turbine wheels, each having, at or near its circumference, a sufficient number of buckets. These wheels are as many in number as the compartments into which the cylinder is divided. Each compartment contains a turbine wheel, and is separated from the adjoining compartment by means of a dividing plate or diaphragm. The foregoing is condensed from his specifications but correctly represents their meaning. He then goes on to say:

"Openings are made in the dividing plates which separate each compartment from the adjoining ones, and the area of these openings is proportioned to the pressure of the steam or other driving fluid, and to the number of compartments and turbine wheels, and to the extent to which it is desired that the driving fluid should be expanded before being finally discharged from the engine. By this means the driving fluid, admitted at its highest pressure into the smallest compartment, passes into the second compartment through openings of such area that it expands to a calculated extent. The same process is repeated, etc."

He says that various forms of turbine may be used, and his first claim is as follows:

"In combination with a rotary engine, the dividing plates between the compartments provided with openings forming communications respectively of varying area between said compartments, the turbine wheels in such compartments, and a driving shaft, substantially as and for the purpose set forth."

Cutler, 1879.

This is a radial outward flow turbine in which the compound principle is used. Steam enters at the bottom, passes to the center and then flows radially outward through the passages between the guides *c c c* and the wheel vanes *d d d*. The rotating wheel *A* has vanes attached to each of its two

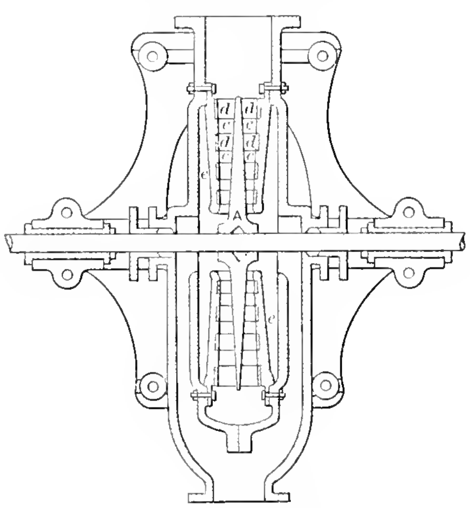


Fig. 23 Radial Outward-flow Turbine.

faces so the pressure is balanced on each side. Expansion of the steam is allowed for in part by the increasing width of the passages and in part by the fact that the steam is constantly flowing from a smaller to a larger diameter of wheel, so that the circumferential area of the passages constantly increases from this cause as well.

Imray, 1881.

This is another attempt to apply the compound principle to a single wheel, having a single set of vanes, but differs somewhat from the turbines of Wilson and Perrigault and Farcot. Steam enters at *A*, passes through the nozzle and impinges against the buckets *C C C*. These buckets are semicircular in shape, as indicated in the sectional view in the upper left-hand corner of the illustration. The steam enters at one side of the bucket, follows the curved surface of the bucket, and discharges into the opposite side of a semi-circular stationary bucket or guide *D*. Here the direction of flow of the steam is again reversed. The steam, as before, flows around the stationary guide surface and discharges against one of the buckets *C*, whence it is carried along to the second stationary bucket, and so on, alternately entering the successive wheel buckets *C C C* and the successive stationary buckets *D D D*. It finally discharges on the opposite side of the turbine casing, at *E*. In the meantime steam enters at *A* on the

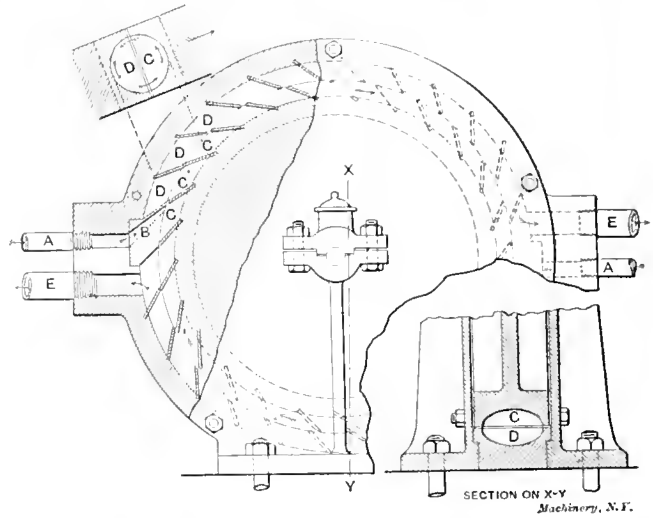


Fig 24. Another Compound Turbine with only one Wheel.

right-hand side of the casing and zigzags through the lower half of the wheel in a similar manner, exhausting at *E* on the left-hand side.

De Laval, 1883.

The first patent of this noted inventor was for a reaction turbine and was taken out in 1883, in several countries. As it was illustrated in the De Laval article in the last number the cut is not reproduced herewith. According to the specifications, steam (or other fluid) enters the wheel at the center through a nozzle, and passes outward through hollow curved arms, escaping at their ends, and causing the wheel to rotate at high velocity. The wheel shaft drives another shaft at a slower speed, by means of friction wheels, the requisite pressure between the friction surfaces being obtained by the axial thrust of the turbine wheel. The principle of this turbine is no different from that of the first American patent by Avery in 1831, but its application to centrifugal cream separators, for the extensive development of which Dr. De Laval has been responsible, was successful and marks the beginning of an important career by this inventor in the manufacture of steam turbines.

Babbitt, 1884.

B. T. Babbitt, besides acquiring fame as a manufacturer of laundry soap, was both an inventor and a mechanic, and one of his inventions related to a steam turbine of the type shown in Fig. 25. This is an inward-flow turbine with two wheels,

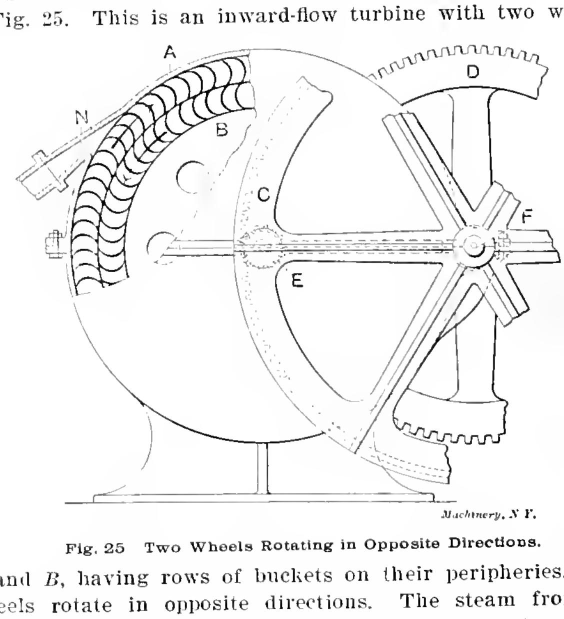


Fig. 25 Two Wheels Rotating in Opposite Directions.

A and *B*, having rows of buckets on their peripheries. The wheels rotate in opposite directions. The steam from the nozzle *N* impinges against the buckets of the outer wheel, which it is supposed to leave with a considerable residual

velocity, and gives up its remaining energy to the buckets of the inner wheel. The chief novelty of the invention is the method of transmitting power from these two wheels to the slow speed shaft F. The turbine wheels are mounted concentrically on two separate shafts, one end of which is shown at E. There is a pinion on the outer end of each of the shafts. One of these pinions gears with the internal gear C on one end of the slow speed shaft F, and the other pinion gears with the spur wheel D on the other end of shaft F.

Isaac Last, 1885.

This is another example where the steam is caused to return upon itself, first flowing radially outward then reversing and flowing radially inward, just as in the Hoehl, Brakell & Gunther turbine, Fig. 19. In the Cutler turbine, however, compounding is carried further than in the former, there being a series of wheels placed side by side on the same shaft. In the sketch, $A\ B\ C$ are the different chambers in which the wheels rotate; $a\ a$ are the guides for directing the steam against the wheel buckets and $b\ b$ are the wheel buckets. One drawing in the patent specifications of Last has a very modern appearance, in that he shows a compound turbine built up of two parts, the high pressure and the low pressure, in each of which is a series of compound wheels like that shown in Fig. 26. The high-pressure and low-pressure sections are connected by a pipe, and their arrangement resembles that of some of the turbines built to-day.

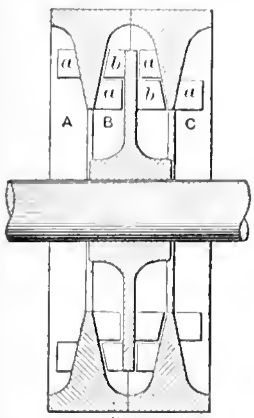


Fig. 26. Combined Inward and Outward Flow.

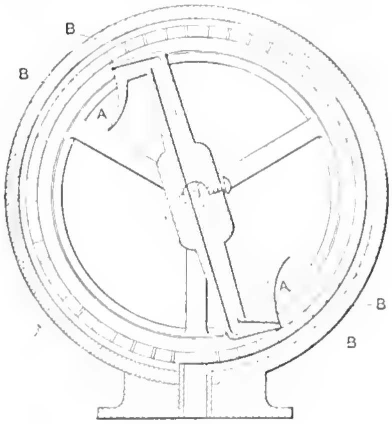


Fig. 29. Denke's Modification of the Reaction Wheel.

Parsons, 1885.

With a patent issued in several countries in this year, the Hon. C. A. Parsons, who was the first to place the turbine on a commercial basis, enters the field. In all his work he has adhered to the reaction turbine and is responsible for the successful development of the compound reaction motor. In Fig. 27 is a section of one of his patent drawings. Steam enters at the center A, and passes right and left between the series of guide vanes attached to the outer casing and the rotating blades attached to the inner drum, which rotates on shaft $B\ B$. Steam escapes to the exhaust passages $E\ E$ and finally to the exhaust pipe shown by dotted lines. The following paragraphs are extracts from his description:

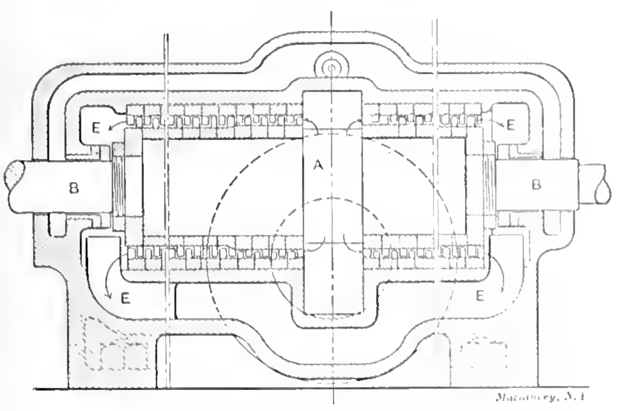


Fig 27. Parsons' First Turbine

"I arrange the portions of the motor to form an approximately cylindrical figure, the whole being mounted upon the same shaft, the first delivering into the second, the second into the third and so on. Each portion comprises a set of fixed and a set of moving vanes, the direction of motion of the actuating fluid being generally parallel, or approximately so. To balance the end pressure upon the cylinder, I mount two similar sets of rotary parts upon one shaft, one set being so placed at each side of the inlet for the actuating fluid that the entering stream divides right and left, and the exhaust takes place at both ends.

"As the speed of the motor will be necessarily high, and perfect balancing of the moving parts would not be practicable, I give to the bearings a certain very small amount of elasticity or play combined with a frictional resistance to their motion."

This refers to the well-known Parsons construction shown in Fig. 28, in which there is an annular space, between the shell of the bearing and the pocket for the shell bored out in the frame, filled with a series of metal rings. Every other ring is bored to fit the outside of the shell, but its outside diameter is smaller than the bore of the pocket, as in $a\ a$. The alternate rings $b\ b$ are turned to fit the pocket, but are bored larger than the outside of the shell. The rings are forced together by a spring s, so that they offer considerable resistance to any lateral movement of the bearing.

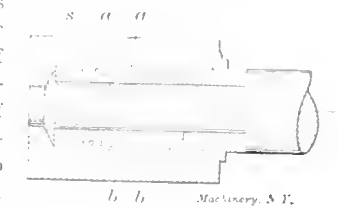


Fig. 28. Bearing of Parsons' Turbine.

He says: "The lubrication is effected by forcing lubricant through pipes to the parts to be lubricated and for this purpose a pump can be employed. To prevent leakage past the shaft at the end covers of the casing, which, when steam is the actuating fluid, would be inconvenient, I form annular recesses in the covers around the shaft ends, and place these recesses in communication with a pipe in which a partial vacuum is maintained by suitable means, such as a steam jet."

In the next year, 1888, Parsons took out a patent in which the turbine wheels are arranged in groups, each successive group being of larger diameter than the preceding one, to allow the steam, as it expands, to flow through larger spaces, as required by the increase in the specific volume of the steam. He also proposes to secure steam-tight joints at the bearings by admitting water under pressure to an annular groove passing around the bearing. He suggests cutting a spiral groove on the shaft, at the section where this annular groove occurs, with the idea that when the shaft is revolving at high speed, the spiral will diminish the quantity of water forced into the turbine casing by the air pressure, when the turbine is running condensing.

A. Denke, 1890.

A simple and interesting though inefficient scheme for taking advantage of the residual velocity of the steam as it leaves the nozzles of a reaction turbine of the Hero type was invented by A. Denke and is shown in Fig. 29. There are two diametrically opposite hollow arms rotating in a casing, on the inner periphery of which is a series of vanes marked $B\ B$. The ends of the arms are bent at right angles, forming nozzles, and the steam which enters at the center flows radially outward and escapes from the nozzles in a tangential direction. The steam impinges against the stationary vanes of the casing and its direction is reversed so that it flows radially inward and strikes the curved horns $A\ A$ attached to the ends of the rotating arms. A simple reaction wheel of this type does not make a practical device because of the high speed at which it must necessarily rotate; but the arrangement shown might possibly be so designed as to somewhat improve the operation of such a wheel.

Altham, 1892.

A compound turbine consisting of two rotating wheels, one inside of and concentric with the other, is the invention of George J. Altham. The buckets of the inner wheel are arranged in its outer periphery and those of the outer wheel in its inner periphery, so that steam will act alternately on the inner and outer wheel, and successively on the different buckets of both wheels, the arrangement being such that the wheels rotate simultaneously in opposite directions. Fig. 30 shows at

the left a cross-section of the rims of the two wheels in which the buckets are cut. The other sketches show longitudinal sections of the rims. Steam is discharged from the nozzle into one row of buckets of the outer wheel, whence it passes to the first row of buckets of the inner wheel, thence to the second row of the outer wheel and finally to the last row of the inner wheel, from which it discharges into the turbine casing. In the smallest sketch, Fig. 30, the construction is indicated where

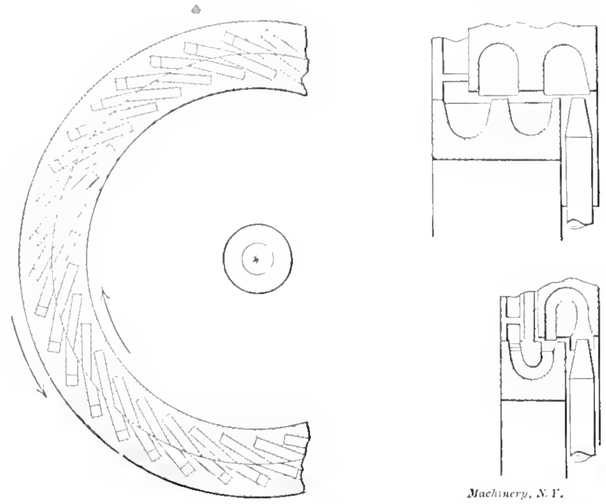


Fig. 30. Compound; two Wheels Rotating in Opposite Directions; no Guide Vanes.

there is only a single row of buckets in each wheel. The course of the steam in this turbine is similar to that in the Imray turbine, 1881, except that in the latter the outer set of buckets is stationary instead of rotary.

Dow, 1893.

When turbines first began to come into prominence in this country the one invented by J. H. Dow was one of the three or four that were most frequently mentioned. His first patent was issued in 1887, and later several others were taken out, but the one showing the most completely worked out design was issued in 1893. All of the Dow turbines are of the radial

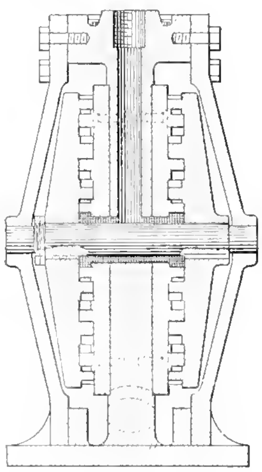


Fig. 31 Section of Origiual Dow Turbine

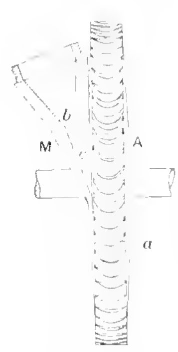


Fig. 34. De Laval Expansion Nozzle.

outward-flow type, consisting of alternating rings of rotating stationary vanes, and in this respect resemble one of Wilson's inventions of 1848. In Fig. 32, taken from his latest patent, *A* is the ring of stationary vanes directing the steam against the ring of rotating blades *B*, and *C* is another ring of stationary vanes, *D* a ring of rotating blades, etc. A peculiarity of his turbines is that the stationary vanes are not curved at their inlet ends in a way to guide the steam into them in the direction in which it leaves the rotating blades, except as the latter might be designed so that steam would leave them in the direction in which the wheel is turning, which would be an inefficient arrangement. In the patent of 1887 there is a single shaft on which are two disks facing each other, having annular rows of vanes cut on their inner faces. Between these two disks is a central stationary disk with annular rows of guide vanes cut on each of its faces. The arrangement is shown in Fig. 31. Steam enters at the center, and flows radially outward between the vanes on each side of the central disk. In his latest patent Dow compounds his turbine still further by providing several rotating and stationary disks ranged along the shaft on each side of the center. Steam enters at the center and gradually works outward toward both ends of the turbine. In his compound turbine he also uses a pair of disks at the center, so designed that they serve as pressure balances and hold the shaft and wheels in an endwise direction.

Parsons, 1893.

In this year Parsons took out a patent on a compound reaction wheel shown in Fig. 33. This is exactly similar in principle to the one already illustrated, invented by Monson in 1862. Later, in 1867, one of the same type was patented by T.

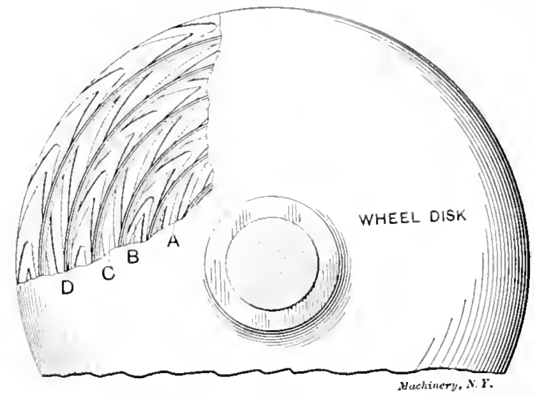


Fig. 32. Dow Turbine.

Banta. This patent of Parsons, therefore, is merely a construction patent and does not cover any principle not previously patented. Steam enters in the steam chest, at the left, passes through the hollow shaft to the first pair of arms, where it flows radially outward, then escapes, through openings at their extremities, into the first chamber. It then passes through a sleeve encompassing the shaft to the second pair of arms, and so on to the end of the turbine. The chief difference between Parsons' and Monson's is the shape of the arms, which Monson made curved and Parsons straight, and the arrangement of the steam channels through which steam passes from one chamber to the next. At one time or another Parsons has patented most of the feasible arrangements for a compound turbine. In 1890 he secured a patent similar in principle to the one issued to Moorhouse in 1877 except that he arranged to have the steam flow radially inward at each wheel and used the reaction principle. In 1891 he secured a patent for a reaction turbine consisting of a series of disks upon the same shaft

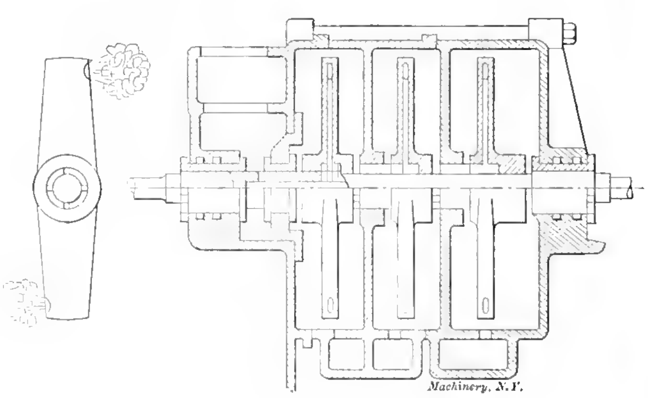


Fig. 33. Parsons Compound Reaction Turbine.

on the faces of which were several rings of blades. The steam flowed radially outward between these vanes instead of passing longitudinally through the turbine, as in the case of his earlier patent.

De Laval, 1894.

De Laval's most important patent relates to his expanding nozzle, in combination with a turbine wheel. It is interesting to note in this connection that the expanding nozzle was patented in this country in 1867, patent 64,539, for steam injectors. De Laval, however, was the first to apply the prin-

ciple of a diverging nozzle for the expansion of steam to a turbine. The two broadest claims of the patent are the following:

1. The combination with a bucket or turbine wheel, of a stationary nozzle opening adjacent to the wheel and having its bore diverging or increasing in area of cross section toward its discharge end, whereby the elastic fluid under pressure is expanded in passing through the diverging nozzle and its pressure is converted into velocity before the jet is delivered against the wheel.

2. The combination with a bucket or turbine wheel, of a stationary nozzle opening adjacent to the wheel and provided with a contracted receiving portion and with a discharge portion having its bore diverging or increasing in area or cross section toward its discharge end.

Maison Breguet, 1894.

Judging from the illustration accompanying this patent, it introduces no new principle that was not included in the invention of Hartman's compound impulse turbine, the patent for which was taken out in 1858. That is to say, the illustration shows a converging nozzle in connection with rotating rings of blades alternating with stationary vanes. This is nothing more or less than what is shown in Hartman's patent drawings. From the way the text of the Breguet patent reads, however, the inventor apparently had in mind the improvement of the De Laval turbine, and if such is the case he evidently intended to imply the use of a diverging nozzle instead of a converging nozzle in connection with a compound turbine. Putting this interpretation upon the patent it is of importance as the first to be issued upon this combination of elements, preceding, as it does, the Curtis patent (which introduced the same principle) by about two years. The description of the invention states that in the De Laval turbine "Even with a circumferential velocity of the turbine of 420 meters, if the steam has a velocity of 1,100 meters, it still discharges from this turbine with a velocity of 440 meters, and this velocity is much higher when the circumferential velocity of the turbine is less. The idea that has naturally come to us is to utilize anew this lost velocity in a second turbine mounted on the same axis, and even in exceptional cases in a third, so as to increase the use of the turbine. We affirm as our property the invention of the compound steam or gas turbine, in which the steam, or gas, after having lost a part of its live force in the turbine buckets, finally loses the remainder in the buckets of one or of several other disks mounted on the same arbor."

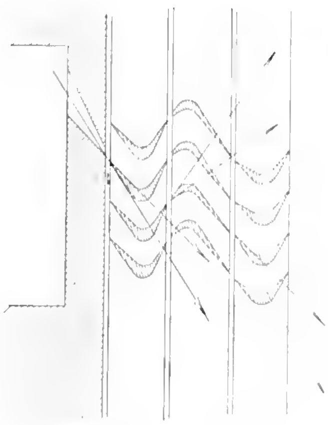


Fig. 35. Patent Issued to the firm Breguet.

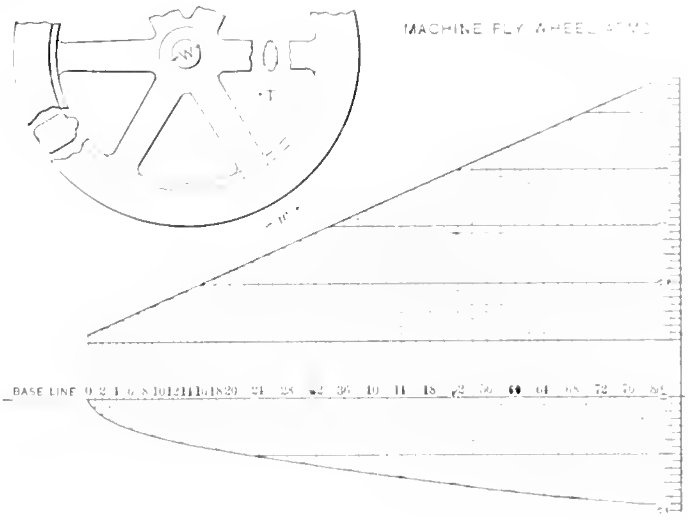
* * *

DATA SHEET FOR NOVEMBER.

The data sheet issued with the engineering edition for this month forms another practical supplement giving the results of the experience of several practical men. It contains some more matter upon gear wheels and pulleys, by Mr. Renkin, who has furnished material for the two preceding sheets upon the subject of gear wheels; and in addition gives the proportions for sheave wheels designed for both wire cables and manila rope. Also proportions for machine flywheels or handwheels.

Previous data upon the proportions of handwheels have been issued in the supplements to the November, 1902, and January, 1904, issues of MACHINERY.

We also have on hand another sheet upon the same subject, contributed by W. H. Raeburn, Dundas, Canada. As there is not room to use this in the data sheet supplement for this month, and since it is similar in character to the information contained in this sheet, we reproduce Mr. Raeburn's contribution below. Subscribers will thus have it to compare with the proportions of flywheels given on the November data sheet. The following are directions for using the diagram here given:



Diagrams for Machine Flywheels.

Find diameter of flywheel on base line. Note the distance above this line to inclined line. Call this distance a. Find area of section of rim of flywheel on base line. Note the distance below this line to curved line. Call this distance b. $a + b = W =$ width of arm projected to center; $w = \frac{2W}{3}$; $T = \frac{1}{2}$ width at any point.

* * *

Eye surgery in its simple forms must often perforce be practiced in the shop by the men, and many shopmen become very handy in removing foreign substances. Cinders and metallic particles, when superficially imbedded in the cornea of the eye, can usually be removed with little trouble by the skillful use of a toothpick or a match sharpened to a point which has afterward been slightly softened by chewing. But for particles more firmly imbedded so as to require more positive means of removal, a metallic instrument with an end shaped something like an oar and highly polished, may be found necessary. If strongly magnetized it will be of greater assistance in removing steel or iron pieces but will be no better for cinders, brass, or other non-magnetic substances. When metallic particles are of a ragged, irregular shape they may defy removal by ordinary means on account of clinging to the cornea with the barbs. In such cases the use of fine silk waste wound around the end of a toothpick is said to give very gratifying results. The silk threads catch upon the particle and tear it loose by simply moving the toothpick back and forth over the affected spot. Bandaging the eye and occasionally bathing it with a strong solution of salt and water is about the simplest and best after treatment to remove the inflammation.

* * *

A prime consideration in ocean telegraphy is to have a receiving and recording apparatus that works with the least possible resistance. The weak electric current that is necessarily used, is totally inadequate to work a Morse sounder or recorder, being the merest fraction of that required to work the most delicate relays used in land service. In Thompson's galvanometer a small mirror is delicately poised so as to be deflected by electro-magnets, and the deflection of the mirror is multiplied by a beam of light which is reflected on a scale. This delicate, but what is now considered to be a crude apparatus, is replaced by recording instruments of equal or greater sensitiveness which obviously have the great merit of producing a permanent record of all messages transmitted. To indicate what the extreme delicacy of this class of electric mechanism is, the improved Orling-Armstrong electrocapillary recorder may be mentioned. It is worked with a current of one-third volt through a resistance of a megohm or 1,000,000 ohms!

VARIABLE SPEED MOTORS.—7.

THE COMMERCIAL ELECTRIC COMPANY'S SYSTEM.

WILLIAM BAXTER, JR.

The variable speed motors manufactured by the Commercial Electric Company, of Indianapolis, are adapted to operate on any two-wire, or Edison three-wire power and lighting circuit. The variation in speed is obtained mainly by varying the number of wires upon the armature. The motor is provided with a double commutator armature, each commutator being connected with a separate set of armature coils. In this respect the system is somewhat similar to that of the C. & C. Company, but in its operation there is quite a difference; for while in the latter the two armature windings are connected in series to obtain a slow velocity, and in parallel for high speed, in the former the two windings are never connected in parallel. Owing to this fact, the two windings need not be made with the same number of turns; the actual proportion

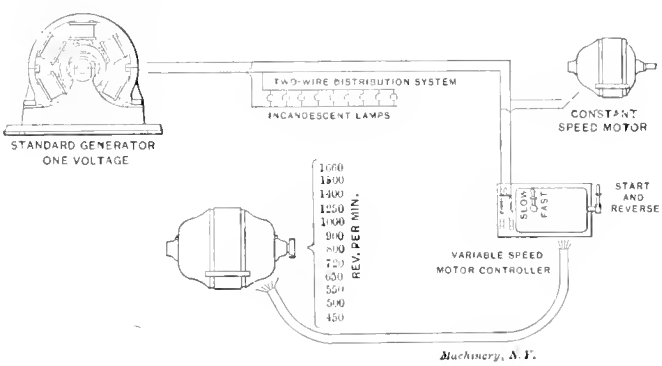


Fig. 1.

used is about two to three. To obtain the lowest speed both the armature windings are used, connected in series with each other. For an intermediate speed the winding having the smaller number of turns is cut out, while for the higher speed this winding is cut in and the one with the greater number of turns is cut out. The speeds obtained with these three connections of the armature circuits are about as follows: Slow speed, with both armature windings in series, 1; intermediate speed with long armature winding in service and short one cut-out, 1.7; high speed with short armature winding in service and long one cut-out, 2.5.

By means of field regulation several steps are obtained between the low and intermediate, the intermediate and high and above the latter speed. The low and the intermediate speeds are increased about 40 per cent. by means of field regulation. and the high speed is increased about 60 per cent., so that the total range of velocities is four to one, which is divided into twelve equidistant speeds.

The diagram, Fig. 1, illustrates the manner in which these motors are connected in an ordinary two-wire system in combination with incandescent lamps and other motors. The controller, which is of the reversible type, can be arranged so as to be actuated by means of a handle mounted directly upon it, or from any convenient point about the machine driven by the motor, through suitable connecting shafts and gears.

Description of the Controller.

The general arrangement of the controller, and the circuit connections between it, the motor and the supply mains, is clearly shown in the diagram, Fig. 2. The construction of the controller can be readily understood from Fig. 3, which shows the working parts, with the casing removed.

In Fig. 2, A A' represent the two armature windings, A being the long one, and A' the short one. As will be seen, these two windings are permanently connected in series with each other, and the operation of the controller is such that when the motor is started, A and A' are both in service. If the intermediate speed is desired, A' is cut out; and to obtain the high speed A is cut out, A' being left in service.

The parts marked from 1 to 21 are the stationary and movable contacts of the reversing switch shown as a rotating cylinder in Fig. 3. The parts marked from 22 to 34 are the contacts of the speed controlling switch shown at the top of Fig. 3. The controller is so arranged that by turning the shaft of the rotating reversing switch the speed controlling switch lever is also rotated; but the latter does not move until the reversing switch has turned far enough to cut out the starting resistance and the series field coils of the motor, so as to leave only the shunt field coils in service, and thus enable the motor to run at a constant velocity for any speed at which

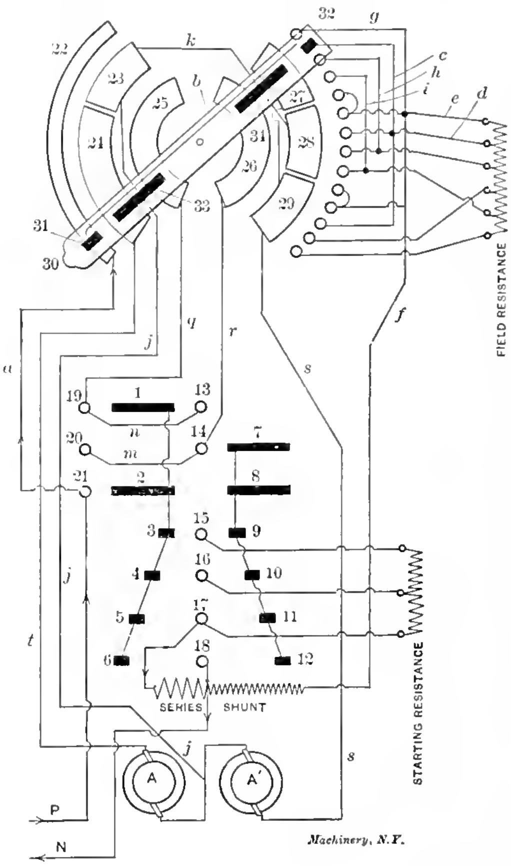


Fig. 2.

the speed controlling switch may be set, regardless of changes in the load. The reversing switch cuts out the starting resistance and the series field coils in four steps.

Circuit Connections and Operation of the Controller.

The circuit connections in Fig. 2 are as follows: The lines P N connect with the source of current supply. If the switch lever 30 is in the position shown, and P N are connected with the mains by closing the main switch, the current from P will flow to 21, thence through a to contact arc 22, and through

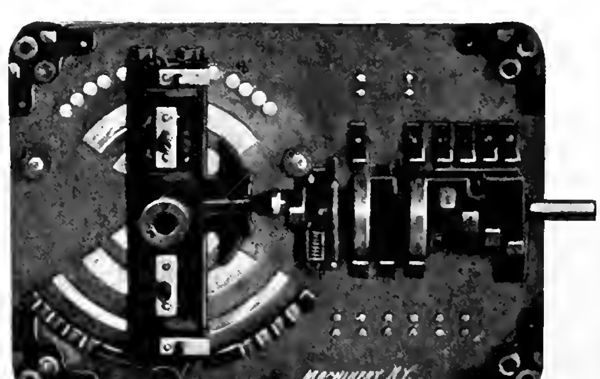


Fig. 3.

contact 31 on lever 30 and wire b to contact 32, and thence through wire c to wire d, and through upper section of the field resistance to wire e, and thus to wire f, which connects with one end of the shunt field coil of the motor. The other end of the shunt field coil is connected with line wire N, thus completing the circuit through the shunt field. If lever 30 were drawn so that contact 32 rested upon the top circular contact, the current would pass directly to wire f, through wire g, and thus avoid passing through the upper section of the

field resistance. This latter is the position of 30 when starting.

If now the reversing switch is turned to the left so as to set the motor in motion, stationary contact 21 will be covered by cylinder contact 2, and 19 by 1. Contacts 7 and 9 will ride over 14 and 15 respectively, and the circuit through the armature will be, from 21 to 2 and 1, thence to 19, to q, to 25 and through connecting contact 33, to 24. From here, through wire t, to armature winding A, through the latter to winding A' and thence to wire s and contact 29. As 29 and 27 are connected by wire, the current will pass to the latter and thence through 34 to 26 and to wire r, which connects with

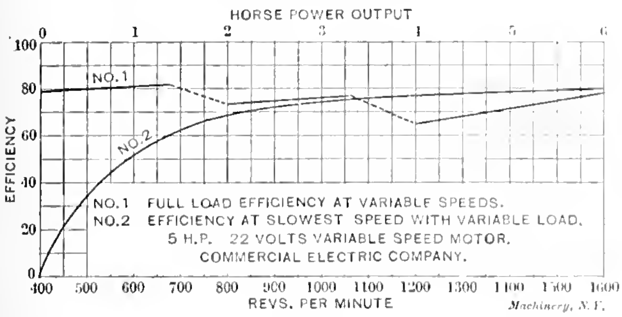


Fig. 4.

14. From 14 through cylinder contacts 7 and 9 the current reaches 15, and then passes through the starting resistance to contact 17, thence through the series field coil to line N.

When the reversing switch is moved to the second step, cylinder contact 10 rides over 16 and cuts out one section of the starting resistance. When the third step is reached contact 11 rides over 17 and cuts out the remaining section of the starting resistance, and on the fourth step contact 12 rides over 18 and cuts out the series field coil.

During all this time the switch lever 30 does not move from its initial position, but, upon the further advance of the controller, 30 rotates clockwise so as to carry contact 32 over the row of circular contacts and thereby cut in sections of the field resistance. While 34 remains in contact with 27 there is no change on the armature winding connections, but the speed of the motor is increased from step to step through the cut-

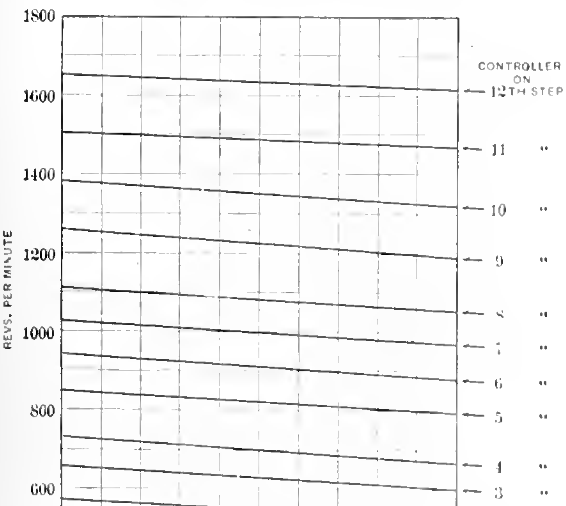


Fig. 5.

ting of resistance into the shunt field circuit. On the first step the current passes through wire g; on the second step it passes through wire c, and cuts in the upper section of the resistance. On the third step it passes through wire h and cuts in the two upper sections of the resistance. On the fourth step it passes through wire i and cuts in the four upper sections of the resistance. In passing to the next step, lever 30 carries 34 over onto contact 28 and at the same time connects with wire c and cuts out all the field resistance. As soon as 34 passes onto 28 the armature winding A' is cut out, because then the current from the junction of the two windings, A and A', can pass through j to 23 and thence, through k, to 28. While 30 is advancing and carrying 34 over 28 the sections of the field resistance are again cut into the field circuit, one at a time, thus increasing the motor speed step by step. When 30 advances far enough to carry 34 over 29, A will be cut back into circuit, and A' will be cut out. As will be seen when this position is reached, 33 will be in contact with 23 instead of 24, so that the current from line wire P instead of

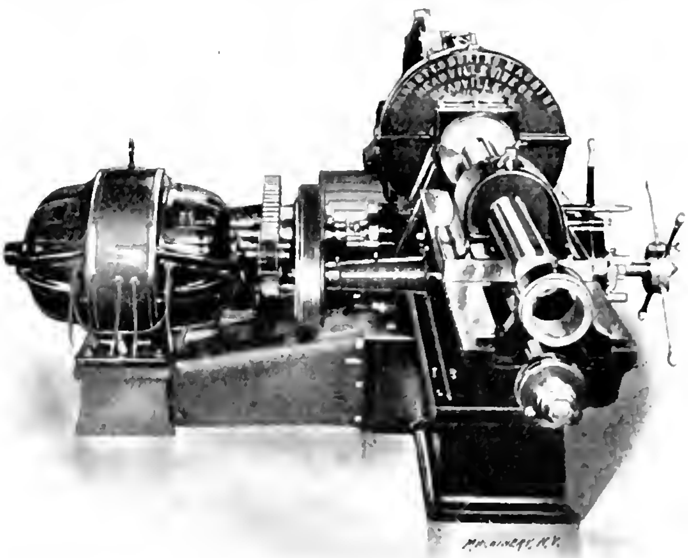


Fig. 6

passing to 24, and thence to t and to A, will pass to 23 and through j to A'; and from the end of A' it will pass to 29 and thence to 26 and out to wire N in the manner already explained.

While 34 is being advanced over 29 the sections of the field resistance will be again cut in, one at a time, and when the final step is reached all the sections will be in service.

In the first two connections of the armature coils only four of the field resistance sections are cut into the field circuit; but in the last connection all the sections are brought into service. In this way the increase in speed obtained by the use of field resistance, for the first two connections is made about 40 per cent, while for the last one it is about 60 per cent.

To run the motor in the opposite direction the reversing switch cylinder is rotated to the right, and then contact 8 rides over 21, contact 7 over 20, contact 1 over 13, and contact 3 over 15. With these changes in the reversing controller connections the path of the current will be as follows: From 21 to 8 to 7 to 20, through m to 14, through r to 26 to 34 to 27 to 29 and through s to and through the armature windings A' A to wire t and to 24. From 24 through 33 to 25, and through q to 19, through n to 13, thence to 1 to 3 to 15 to 17, and through the series field coil of the motor to line N. As the controller is advanced the contacts 4, 5, 6 slide over 16, 17 and 18, one after the other, and cut out the starting resistance and series field coils as previously explained. The further advance of the controller actuates the speed controlling switch 30 in the manner already described.

Torque, Power and Efficiency of "Commercial" Motors.

When the two armature windings are in service the current traverses about two-and-a-half times as many turns of wire as when the short winding is used alone; hence, with the same strength of current, the torque in the two cases will be about in the ratio of two and a half to one. For any portion, or the whole of the armature wire in service, the torque with a given current through the armature will decrease as the field is weakened, or, in other words, as the speed increases. The reduction in torque will be directly proportional to the increase in armature speed. From this it will be seen that the power developed by the motor will be practically the same at all velocities.

When all the armature wire is in service, the loss of energy

in the armature will be greater than when either of the windings is used alone, for the same current strength, but if the armature resistance is small, this difference will have only a slight effect on the motor efficiency. The diagram, Fig. 4, furnished by the Commercial Company, shows that at full load

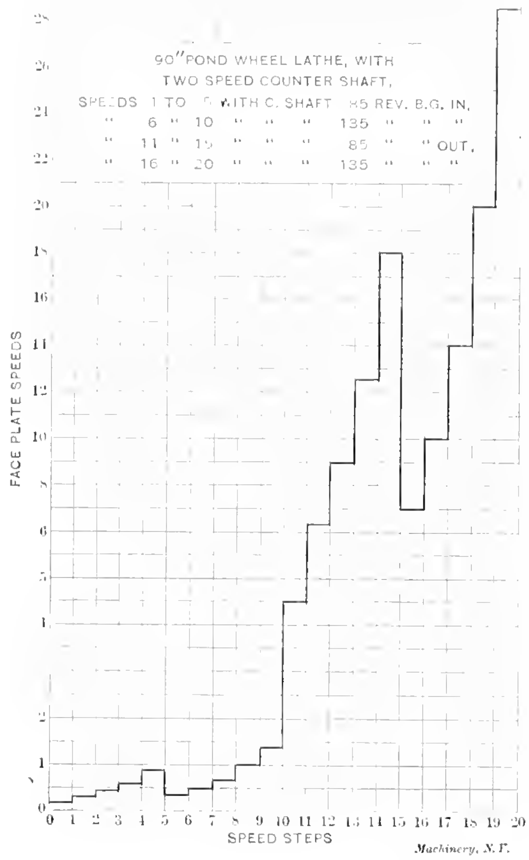


Fig. 7.

the efficiency of the motor changes but slightly for any speed from the lowest to the highest. This diagram also shows, in curve 2, that at the lowest speed the efficiency remains high as the load is reduced to about 25 per cent. of the maximum; below this point the efficiency naturally drops rapidly.

Variation in Speed Due to Changes in Load.

As already explained the motor when running has all the resistance cut out of the armature circuit, and also the series

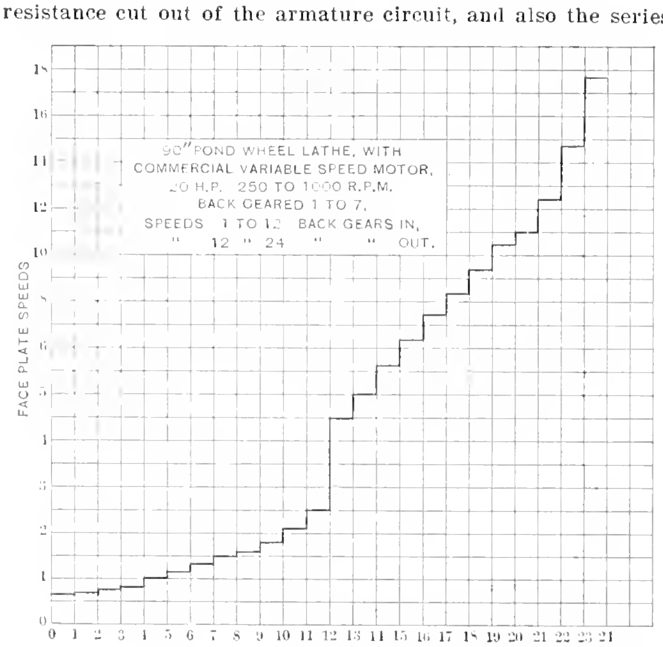


Fig. 8.

field coils; therefore, when the speed controller is set for any given velocity the change in speed effected by varying the load cannot be very great. What this change actually amounts to is shown in Fig. 5. At the bottom of the diagram the power output is marked, and on the left side the revolutions per minute. On the right side the several steps of the speed controller are marked. The speed lines across the face of the diagram show that between full load and no load the change in velocity is about fifty revolutions per minute. Thus on the 10th step the velocity with full load is about 1325, and with no load about 1375.

The way in which Commercial motors are mounted upon machine tools is well shown in Fig. 6.

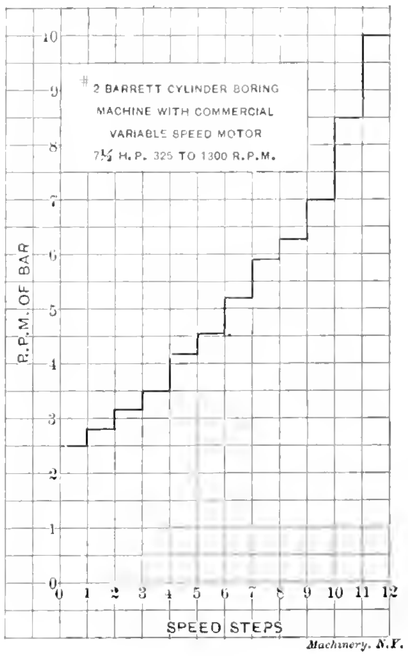


Fig 9.

Some Points on Speed Variation.

Diagrams 7, 8 and 9 show that in some cases the speed variations effected by the mechanical speed-changing devices furnished with machine tools are not as uniformly progressive as they should be, and that in such cases an improvement can be made by using a variable speed motor to produce a part of the speed variation. A perfect speed-changing device would be one in which each step produces a proportionate increase in velocity. In many machine tools, however, the relation of the gearing is such that when the back gear is thrown out and the belt is placed on the slowest cone step, the velocity is materially reduced. This fact is clearly brought out in Fig. 7. In this diagram the speed advances during the first five steps, but here the countershaft speed is increased and the speed of faceplate drops on the 6th step to slightly more than it is on the 2d. The speed again advances uniformly up to the 10th step, when it takes a decided jump in consequence of the change in countershaft speed and the throwing out of the back gear. At the 16th step there is another decided drop in faceplate speed due to changing the countershaft speed.

Fig. 8 shows the same tool driven by a variable-speed motor instead of a two-speed countershaft, and, as will be noticed, the faceplate speed variation is far more uniform; in fact the only break, occurring on the 12th step, is due to throwing the back gear out. If the back gearing were properly proportioned to the range of motor velocities, this sudden rise in velocity when the back gear is thrown out could be prevented. The same result could be obtained by providing a motor with a somewhat greater range of speeds.

Fig. 9 shows the speed variations obtained on the tool of a boring mill by the use of a variable-speed motor alone.

* * *

The artificial corundum, called "cornbin," that is obtained from the slag produced by the Goldschmidt thermit welding process, is much purer than the natural corundum. For this reason it is possessed of a very valuable property to the chemist, and that is the ability to resist sudden great changes of temperature without breaking. Chemical vessels made of fireclay and corubin may be heated redhot and plunged into cold water without breaking or even showing any tendency to crack.

THE DE LAVAL STEAM TURBINE AND ITS MANUFACTURE.

In the Engineering Edition for October was published a general account of the inventions of the noted Swedish engineer, Gustaf De Laval, together with a description of the steam turbine machinery manufactured in this country under his patents, and a description of the De Laval Steam Turbine Works at Trenton, N. J., where the machinery is produced. In this article it is intended to enter more into detail upon the construction of the De Laval steam turbine and the interesting methods of manufacture that have been developed at the American works.

The plant is unusually well equipped with jigs, fixtures and special tools. Micrometers and gages are in evidence, not only for tool room use but for the employes in the shop as well. There is a large tool-making department, which apparently is kept busy, in addition to the tool room where the tools are stored, to be checked out in the usual manner. The drawings are kept in the tool room and an ingenious system is used in giving them out to the workmen. The turbine parts are marked with a number designating the particular part, prefixed by a letter for the size of the machine. Each drawing is devoted to a single part and bears the same character as that part. A board hung in the tool room contains a large number of pins having numbers corresponding to those of the turbine parts. When a workman hands in his check for drawing R-126, for example, it is hung on pin 126 and a small metal clip, lettered R, is slipped over the edge of the check. The number on the check shows who the workman is; and the clip, together with the number of the peg on which the check hangs, shows what drawing has been given out.

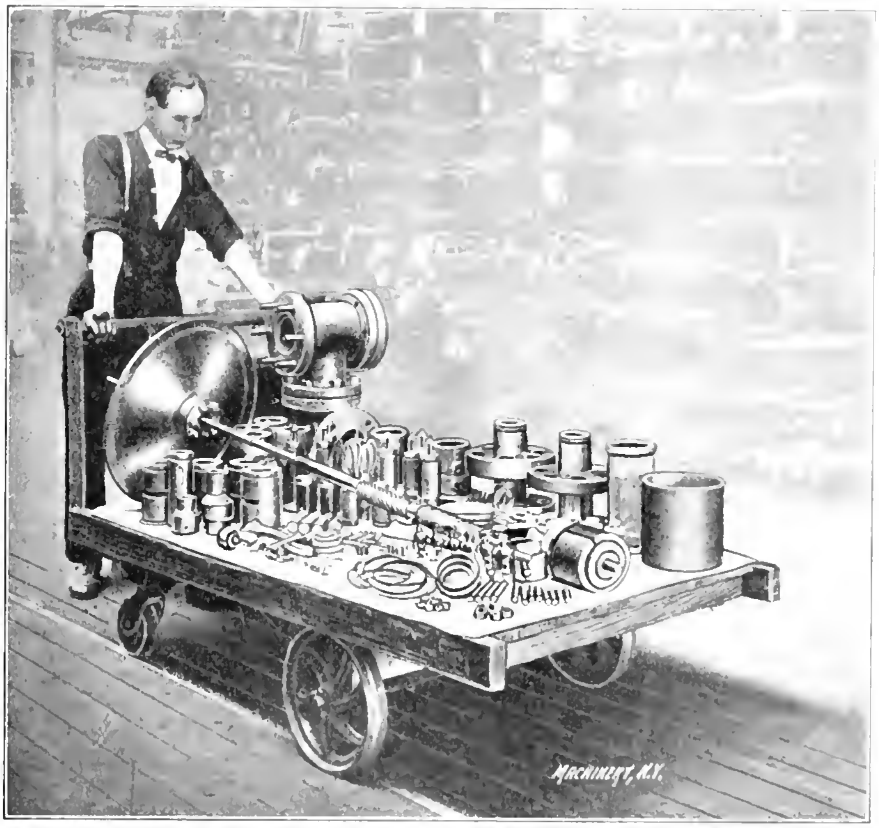


Fig. 1. The Small Parts of a 300 H. P. De Laval Turbine as taken from the Stock Room ready for Assembling.

Another feature of the De Laval works is the stock room for finished parts. All the small pieces are made up in large numbers, carefully inspected and placed in stock. The larger parts consisting of the frames, bedplates, etc., are also made up in lots, though of smaller numbers, and when one or a series of turbines is to be erected, the parts are taken from the stock room, complete, and ready to put together, with the exception of such slight fitting as may be required during the assembling.

In Fig. 1 is shown a truck, loaded with the small parts of one complete turbine, as it is brought from the stock room to be carried to the erecting shop. Here are the wheel and shaft, the gearing, bearings for the several shafts, flexible couplings for connecting the gear shafts with the generator or other machine to be driven by it, the steam nozzles, valves, governor, regulating valve, lubricator, etc.

The line drawing, Fig. 2, is a horizontal sectional view of a turbine, taken through the turbine and gear shafts. Starting at the right, W is the turbine wheel, attached to the flexible shaft which is supported on each side of the wheel by bearings held in the casing by ball and socket joints. The pressure within the turbine casing is practically atmospheric pressure when running non-condensing, and is equal to the pressure of the condenser when running condensing. Under the latter conditions, these bearings should be tight to prevent leakage of air into the casing, and they must at the same time be able to move slightly, in case of flexure of the shaft. They are, therefore, held to their seats by spiral springs N bearing against a collar O made in the form of a socket. At the other end of the flexible shaft are the spiral pinions K, supported on each side by bearings C in the wheel casing. These pinions mesh with the gears I I, as indicated.

The speed reduction between the pinion and gears for all sizes of turbines is about in the ratio of 10 to 1. The speeds of the turbine wheels range from about 30,000 revolutions per minute for a 7-horse power to 10,600 for a 300-horse power turbine; and the speeds of the large gears range from about 900 to 3,000 revolutions per minute. The peripheral speed of the turbine wheels ranges from about 515 to 1,380 feet per second, while the peripheral speed of the gears is 100 feet per second or slightly more, for all sizes. These speeds of the gear shaft are found to be well adapted to driving generators and other apparatus, such as centrifugal pumps blowers, etc. Such apparatus is driven through flexible couplings taking power from the outer ends of the gear shafts. The couplings have a series of pins F, Fig. 2, securely driven into holes in the circumference of the driving disks, and on their outer ends have rubber bushings E, which fit in corresponding holes in the disk attached to the shaft belonging to the generator or other apparatus. These bushings are fitted with an internal steel bushing D, which slips over the end of pin F, to protect the rubber. This brings the wear on the outside of the rubber bushing, which presents a greater area than the inside.

The governor, shown at M, is of compact design and is carried by a short shaft made a taper fit in the end of one of the gear shafts. The governor controls a throttle valve and also, in case of extreme increase in speed, opens a valve admitting air to the wheel casing by means of the lever V.

Nozzles and Steam Chest.

In considering the individual parts of the De Laval turbine more in detail the first to be noted are the nozzles which direct the steam against the wheel buckets and which have been one of the characteristic features of the De Laval system. These nozzles are arranged about the circumference of the steel casting which serves as the casing for the turbine wheel. The inner end of this casting has an annular closed space, separate from the wheel chamber, which serves as a steam chest for the turbine, as indicated in Fig. 2. The inner ends of the nozzles open into this steam chest, as shown in the sectional view, Fig. 3. Here A is the steam chest; B, the nozzle; D, the turbine wheel, and C, the valve for admitting steam to the nozzle. The divergence of the nozzles depends upon the steam pressure to be used and also upon whether the turbine

is to run condensing or non-condensing. If the latter, the turbine is generally fitted with both condensing and non-condensing nozzles, so that in the event of difficulty with the vacuum the machine can be operated non-condensing with a greater degree of economy. These nozzles are turned to gage on their outside and reamed to the required taper on the inside. Over 600 reamers of different tapers are kept in the tool room for this purpose. The nozzles are simply driven into place in the casing, but are threaded at their inner ends to facilitate removal by means of a jam nut. The taper of the nozzles ranges from about 6 to 12 degrees total taper, and they are located with their outlet about $\frac{1}{8}$ inch from the wheel blades.

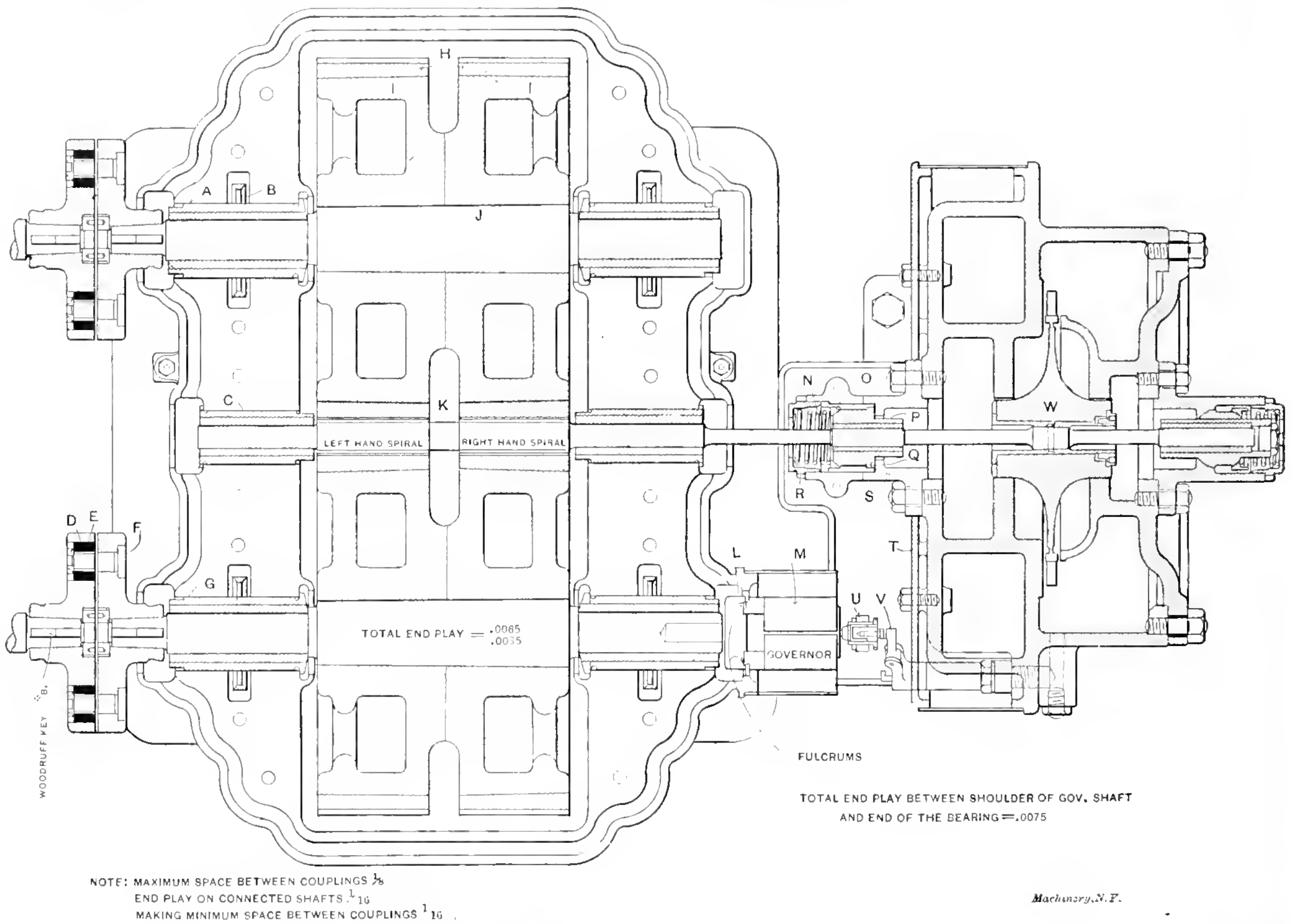


Fig. 2. Horizontal Section of De Laval Steam Turbine.

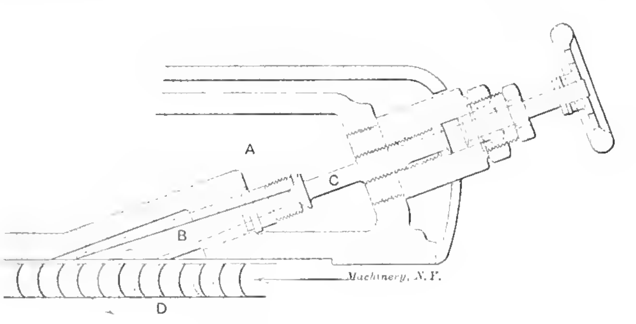


Fig. 3. Section Nozzle and Valve.

Turbine Wheel and Shaft.

The turbine wheels are all made in Sweden, of a special grade of high-carbon steel. They are shaped according to theoretical calculations, so as to offer nearly a uniform resistance throughout to the forces acting; but they are made slightly stronger near the center. A short distance from the periphery annular grooves are turned on each side of the wheel, making this the weak section which would be ruptured first in case of excessive rotative speed. To further guard against danger in the case of a wheel bursting the casing is a steel casting strong enough to sustain the shock due to flying segments of the wheel; and still further, the hubs of the wheel extend into circular openings in the casing, as shown in Fig. 2, in which the hub ordinarily runs without touching. But if the wheel rim should burst, what would be left of the wheel would be out of balance and would cause the hubs to bear against the casing with great force and thus slow down, and perhaps stop the turbine before further damage could be done.

Grooves of the shape shown in Fig. 5 are drilled and milled through the turbine rim in a crosswise direction, and in these drop-forged steel buckets are fitted. This construction enables buckets to be easily renewed, as is sometimes necessary either because of wear or accident.

In the smaller size turbines the wheels are attached to the flexible shafts by the method indicated in Fig. 2. The hubs of the wheels are bored out and a thin steel bushing is drawn into the hub by a nut at one end. The middle portion of the bushing is bored tapering and fits on a taper portion of the shaft, as indicated. This taper is the standard $\frac{1}{2}$-inch per foot used by the De Laval Company. After forcing the bushing on the shaft, it is pinned into place; but the wheel can easily be removed by loosening the nut and sliding it off the steel bushing. The wheels for the larger turbines are made as in Fig. 4. Here the hub is solid at the center, but each end of the hub is recessed and the flexible shaft is made with enlarged flanged ends which fit into the recesses and are bolted solidly in place. The recesses and shaft ends are machined on a taper of $1\frac{1}{2}$ inch per foot, which enables the parts to be accurately centered and fitted solidly together.

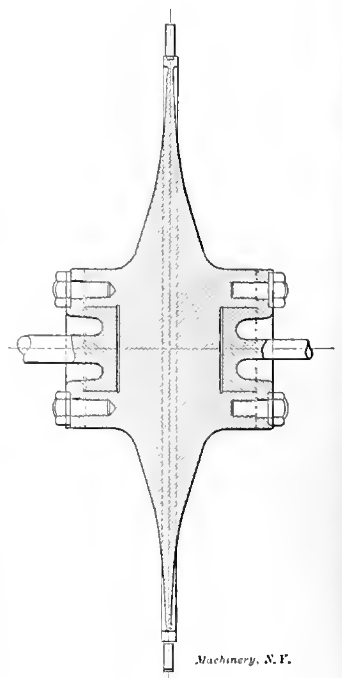


Fig 4. Section of Turbine Wheel.

The pinions are cut directly on an enlarged portion of the shaft. The steps of manufacture are: First, to straighten, turn and square up the various shoulders on the shaft; second, to rough-cut the pinions; third, to finish by grinding, and fourth, to take the finishing cut on the teeth of the pinions. The shaft and wheel are then assembled and tested on centers, where they are run at high speed to determine the accuracy of balance. The flexibility of the shaft, which is an

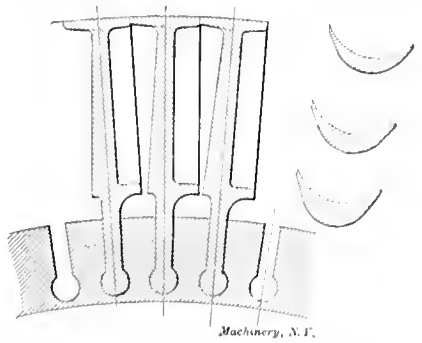


Fig. 5. Showing Construction of Turbine Buckets.

important feature of the De Laval turbine, makes an extremely accurate balance unnecessary since the wheel and shaft reach the critical speed, so-called, at about 1-5 to 1/8 of the normal number of revolutions of the wheel, at which point "settling" takes place and the parts proceed to rotate about their center of gravity instead of about their geometrical center.

Gears.

Next in importance to the turbine wheel, and probably first in importance in so far as the successful operation of the turbine is concerned, are the gears used to reduce the speed of the turbine shaft to a point where it is practicable to utilize the power. It was a radical step on the part of De Laval when he first attempted to run gearing at so high a speed as these gears operate, and it is safe to say that previous to the time when De Laval demonstrated that gears would run at a linear velocity of upward of 100 feet per second, it would not have been supposed possible.

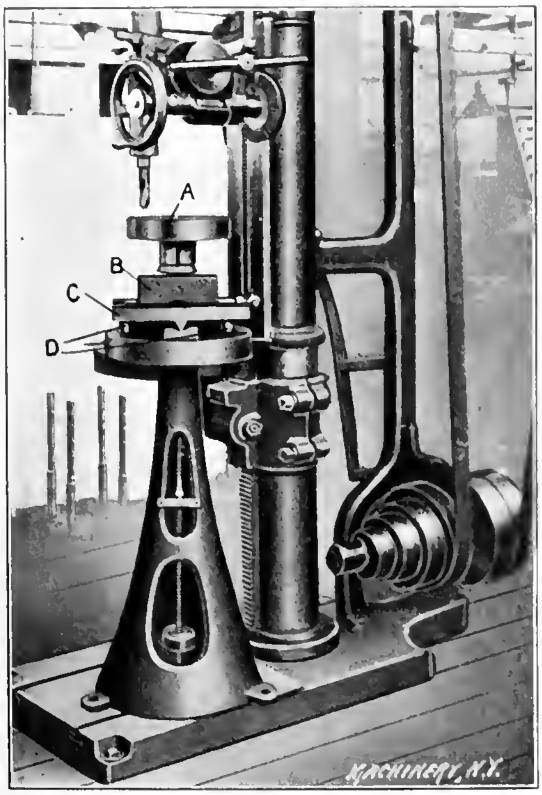


Fig. 7. Machine for Balancing the Rotative Parts of the Turbine.

The pinions are made of 60- or 70-point carbon steel and are a part of the flexible shaft. The gears are of mild 20-point carbon steel of a grade similar to that used for car wheel tires. For turbines up to 30 horse power the gears are of solid steel; but for sizes above that they are made with cast-iron centers with rims of mild steel. The teeth are of fine pitch, ranging from about .15 inch in the smallest to .26 inch in the largest sizes. The success at running these gears at high speed is due, in part, to the fine pitch and the spiral angle of the teeth, which thus brings a large number of teeth in mesh at one time, making the working pressure at each tooth very light, and reducing the likelihood of abrasion. The dimensions of gears and pinions for four sizes of turbines are shown in the accompanying table:

H. P.	Outside Diameter.	Number of Teeth.	Depth of Teeth
PINIONS.			
10	1.077	21	.075
75	1.53	19	.1169
110	1.82	23	.1169
300	2.65	31	.1275
GEARS.			
10	10.1	208	.075
75	15.7	208	.1169
110	18.89	250	.1169
300	29.29	362	.12750

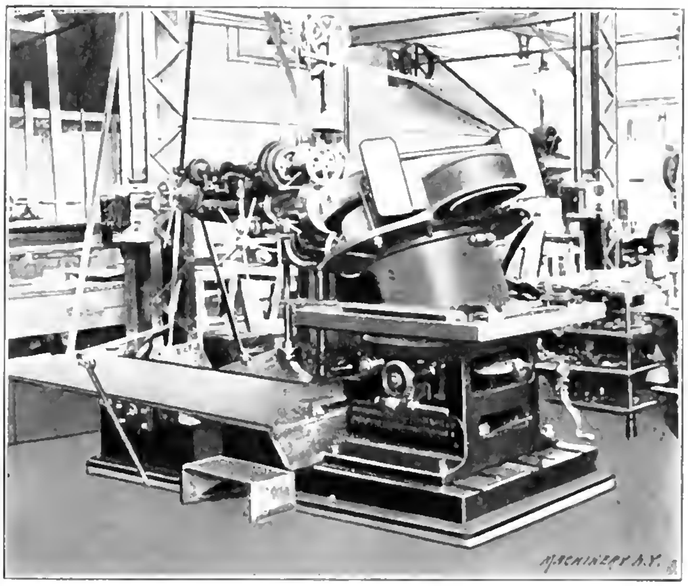


Fig. 6. Boring the Holes in Wheel Casing for the Nozzles, by means of a Special Fixture on the Boring Machine.

A practice somewhat out of the ordinary is employed by the De Laval company in putting together the shafts, gear centers and rims that make up the large gears, as well as in other parts of the turbine, where applicable. This is the use of the 1/2-inch per foot taper already referred to. The angle of this taper is so far below the so-called friction angle, or angle of repose, that pieces turned to this taper and fitted together hold with practically as great rigidity as straight, parallel surfaces would hold and at the same time can be pressed together much easier and without abrading the surfaces. The taper accomplishes the same object as where the surfaces to be pressed together are turned in steps, and on the whole this is a more easily applied system when fitted up for it.

Balancing

Inasmuch as the disks are quite accurately balanced when they reach the factory, and moreover are mounted on a flexible shaft, it answers every requirement to run them on centers in the usual manner, in order to test their balance. The parts of the turbine attached to the gear shafts, however, are not flexibly supported and are better balanced by a more accurate means. The machine shown in Fig. 7 was devised for this purpose, and is shown with one of the flanges for a flexible coupling mounted on an arbor at *A*, ready for balancing. The machine is placed under a drill press and by its aid the heavy side of the casting is located and enough metal drilled out to bring the flange into balance. On top of the stand are located knife edges which carry a table *C* with a movable cross-slide *B*. This cross-slide is fitted with a pendulum in the form of a screw which runs down into the base and has a weight at its lower end. Half way up there is a pointer and a graduated scale for indicating the position of the pendulum. The arbor for supporting the piece to be balanced is at the top of the slide *B*. By adjusting the slide one way or the

other the indicator is brought exactly at the center of the scale and then the coupling is turned around half-way by hand without moving the slide. If the indicator does not move, it shows that the coupling is in balance at this point; if it does move, the coupling must be out of balance and the necessary drilling is done. From eight to a dozen points around the circumference of the coupling are tested in this manner. In order to steady the table and avoid wear of the knife edges when drilling, there are pins *D D* which are raised against the bottom of the table by a cam and which take the strain.

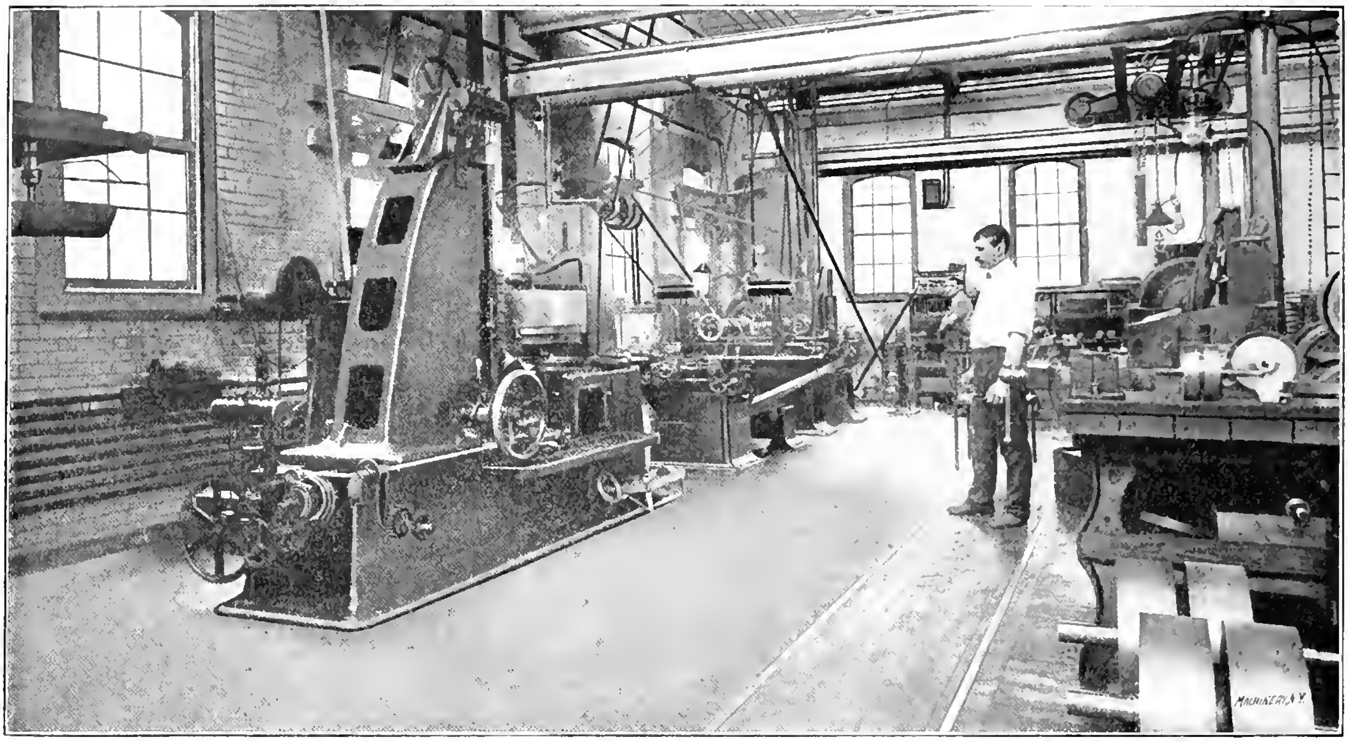


Fig. 8 Gear-cutting Department equipped with Special Machines for Hobbing the Teeth of Spiral Gears.

Gear Cutting

As a matter of course high-speed gears must be accurately cut and their shafts mounted in their bearings so as to be exactly parallel, if smooth running is to result; and unusual precautions are taken to secure a high degree of accuracy in cutting and mounting the gears of the De Laval turbine. Fig. 8 shows the gear-cutting department with its complement of machines built expressly for this work by the Pratt & Whitney Co., Hartford, Conn., in accordance with designs furnished by the De Laval Steam Turbine Co. In these machines the gears are cut by a hobbing process, a spiral cutter being used for a hob. The principle of operation is shown in Fig. 9. At *A* the spiral hob is set so as to cut the teeth of a spur gear. The hob feeds downward across the face of the gear and at the same time the gear rotates as fast as it would be turned around if the hob were a worm meshing in the teeth of the gear. If the hob has a single thread it would have to make as many turns as there are teeth in the gear for each rotation of the gear. At *B*, Fig. 9, the hob is shown inclined still more so as to cut spiral teeth on the wheel. This can be accomplished by giving the cutter either a greater or lesser number of revolutions for each rotation of the gear, according to whether a right-hand or a left-hand spiral is to be cut. In producing a gear the cutting action is continuous from start to finish, so that if the machine is rigid, the best possible results are attained.

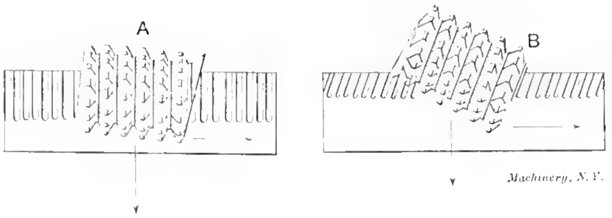


Fig. 9. Illustrating the Principle of the Cutters.

There are two vertical machines and two horizontal machines in the gear-cutting department working on this plan. In order to secure great accuracy in the angle of the teeth, the machines are all provided with an attachment shown in principle, though not in actual detail of construction, in Fig. 10. *C* is the cutter head, which travels downward with the cutter in a vertical direction. *G* is the gear to be cut, mounted on the work spindle which is revolved by a wormwheel. The wormwheel and gear blank are driven by a worm which is given the desired rate of rotation by a system of change gears. Now it is evident that if the change gears used do not produce exactly the right result the correction could easily be made if some means were provided for moving the worm bodily in a longitudinal direction, so that in addition to its driving the wormwheel through its rotation, it also either pushed it ahead or pulled it backward, so to speak. This is what is done by means of a slide shown at *D*, arranged to swivel on a graduated dial which moves up and down with the cutter head. The worm is carried by a sliding frame having a block *R* traveling in the slide *D* so that, when the slide is placed at an angle, any movement of it up or down will give the worm its longitudinal movement. As the slide can be set very accurately by vernier readings, exactly the correct spiral angle can be obtained, independent of the change gears.

Testing the Gearing.

The need for securing so great accuracy of angle will be evident when it is remembered that not only are double spiral

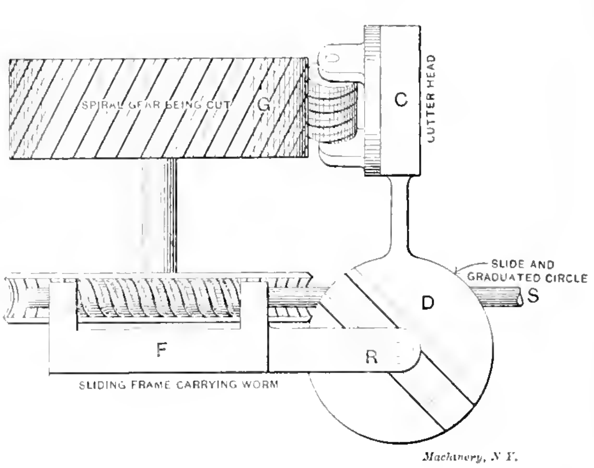


Fig. 10. Diagram showing Method of Securing Accuracy of Spiral Angle of Gear Teeth.

gears used in each turbine, cut right and left, but also that the two right- and left-hand pinions on the turbine shaft lie between two pairs of gears, making what are really two spiral pinions, each of which must mesh with two opposite spiral gears. This will be clear from reference to Fig. 2, which shows the positions of the gears. It goes without saying that

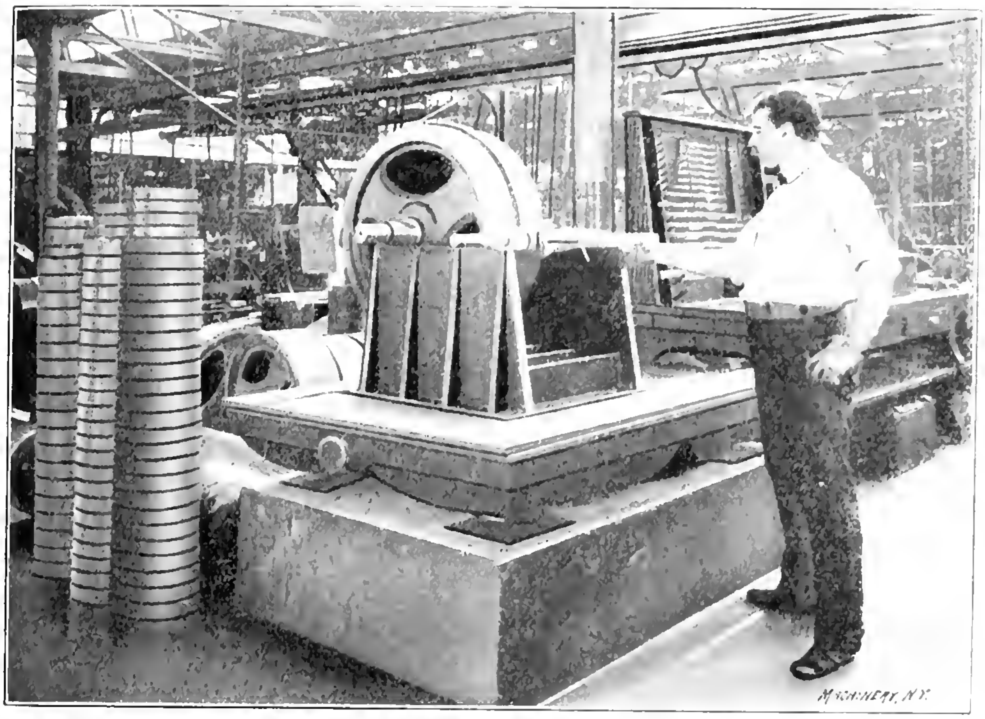


Fig. 11. Testing the Spiral Gears and Pinions to see that Shafts are parallel and in same Plane

it requires rather unusually fine workmanship and painstaking care to have these teeth so correctly cut that they will all mesh in perfect alignment. The method of testing for the angle of the teeth is shown in Fig. 11. There are two parallel straight edges with their top surfaces lying exactly in the same plane upon which the gears are mounted. The gear shafts rest on the top edges of these parallels, and a pair of large gears and a pair of pinions are clamped together, with their teeth in mesh, by an iron band passing around the large gears and arranged with a screw which draws the pinions into contact with the gears. If the two shafts lie in the same plane it is evident that a piece of tissue paper under each end of the pinion shaft would just "draw," and this is the test applied and actually required before the gears are considered to be aligned correctly. A little consideration will show the extreme accuracy of this test, and will indicate how much attention is given to securing the correct spiral angle of the teeth.

The Wheel Casing.

Without correctly aligned bearings the most accurate gear would run noisily, and Fig. 12 illustrates the simple yet effective method used to secure parallelism of the three gear shafts and also to make sure that they are in the same plane. The gear case is first bored out on the horizontal boring machine, being held in a special jig. The bearing pockets are afterward carefully scraped to standard test bars which are brought to their proper center distance by the use of a caliper gage, as shown in the illustration. The gear case rests on a large surface plate and a Brown & Sharpe test indicator, also shown, is employed to bring the test bars into exactly the same plane. This is done by placing the indicator on the surface plate under the shafts at the various points where they protrude past the case. The surface plate is mounted on a heavy foundation and has adjustable legs, so that it can be readily leveled.

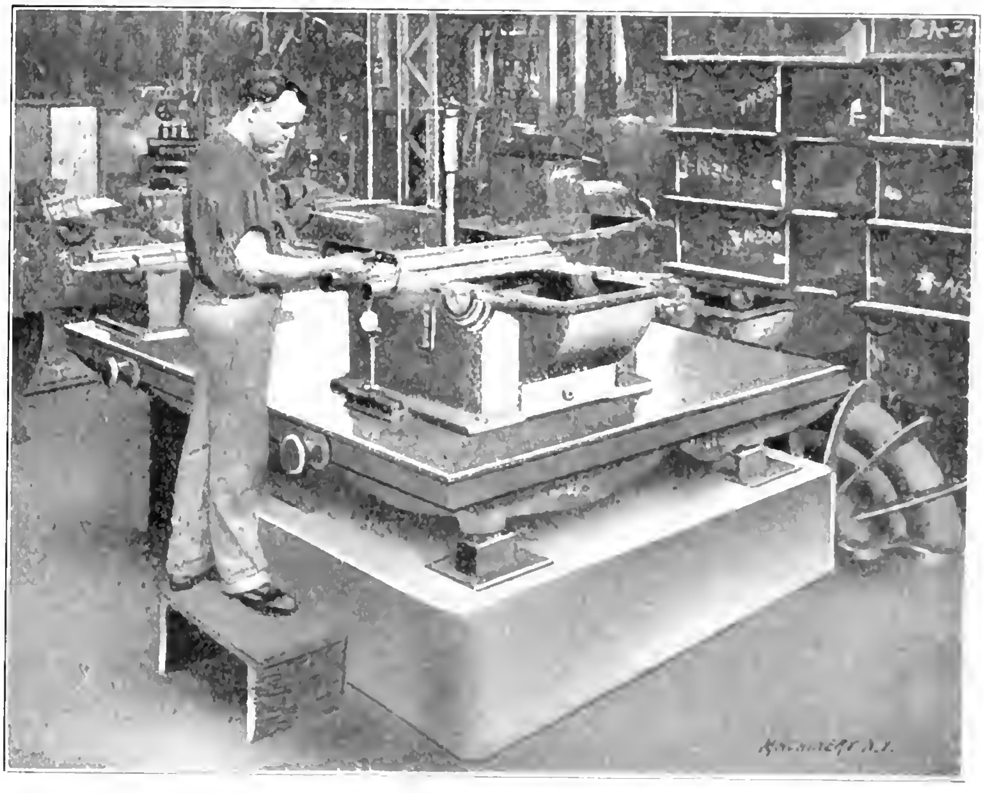


Fig. 12. Testing Pockets for Bearings in Wheel Casing to insure that Gear Shafts will be Parallel and in the same Plane.

Bearings.

All bearings are lined with babbitt and special attention must necessarily be given to their construction to have them adapted to the high speeds of the parts that run in them. The bearings are all in the form of cylindrical shells, either split or solid, excepting those which act as glands in the turbine casing which are turned in the form of a ball at the center and are held in position by sockets. The low-speed bearings are made with cylindrical shells of special composition, lined with babbitt and ring-oiled. Before babbitting, the shells are cleaned in nitric acid. The babbitting is done by first heating the shells and then bedding them in molding sand and pouring in enough babbitt to fill the shell flush with the top. The molten metal is then agitated by means of a stick, which causes the impurities to rise. By this process such impurities reach the center of the bearing, where they are bored out, leaving a solid lining of pure metal.

In the high-speed bearings oiling is accomplished by having a shallow spiral groove turned in the shell, which allows the oil to reach every part of the bearing. In a 100 horse power machine this groove is about 1-64 inch deep of 1/2-inch pitch. The bearings are first milled and scraped together and then bored and reamed under the drill press in a special jig shown in Figs. 15, 16 and 17, before they are turned. Figs 15 and 16 illustrate the drilling of a split bearing, and Fig. 17 the drilling of a solid bearing. The jig is

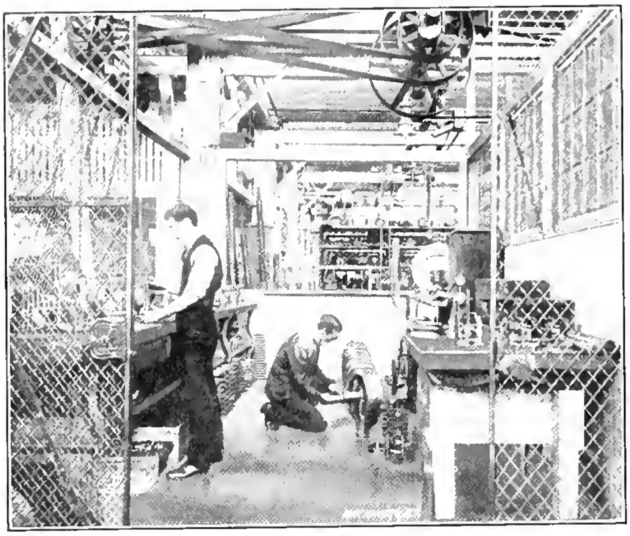


Fig 13 Inspecting Department. This Room is enclosed to Guard against Interruptions that might lead to Errors or Oversight on the part of the Inspectors.

box-shaped with a swinging holder at the top in which the drill bushings are located. Fig. 16 illustrates the method of locating split bearings in the jig so as to insure drilling and reaming of the hole in the exact center of the bearing. The center plate which the man has in his left hand, and which is shown standing beside the drill press in the other views, is inserted in grooves milled in the jig so that one face of the plate is exactly in line with the axis of the bushing through which the hole is to be drilled. The split bearing is then placed with its milled edges against the face of the plate, Fig. 16, and two sliding V-clamps are brought up so as to hold it against the plate, and at the same time align the bearing in a vertical direction. The plate is then removed and the other half of the bearing is placed against the first half, and two more sliding vees are brought up against this second half, on the opposite side of the jig. After this the bushing is brought into position, if it is to be used.

a gage glass, to indicate the quantity of oil in them. The oiling of the various bearings is effected by means of a single sight-feed lubricator having tubes leading to them.

Other Departments.

Fig. 14 shows the machine recently constructed for cutting out asbestos gaskets, which are used chiefly in the pipe joints. They vary from 4 and 5 inches in diameter up to as high as 38 inches in diameter. They were formerly cut out by knives, with the result that considerable material was wasted. The gaskets are now cut out on the top of a table on which is fastened a sheet of zinc and at the center of which is located a center pin on which swings an adjustable cutting rod, which the man in the illustration has in his hand. This

Fig. 14. Device for Cutting out Asbestos Gaskets

rod carries from 1 to 6 adjustable knife rollers. These rollers can be clamped to any point on the rod and fastened by thumb screws. By swinging the rod around very smooth gaskets are cut with one or two turns. Lying on the floor are a number

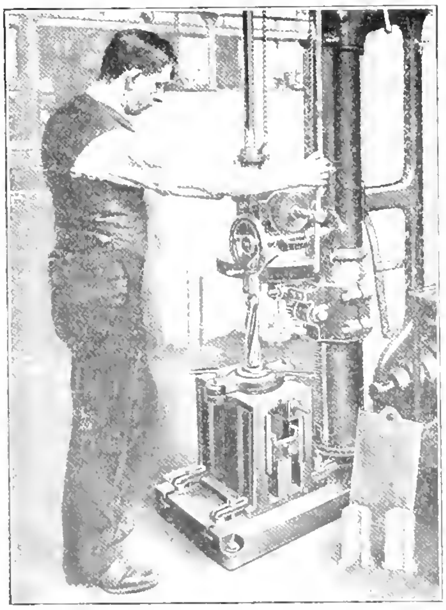


Fig 15

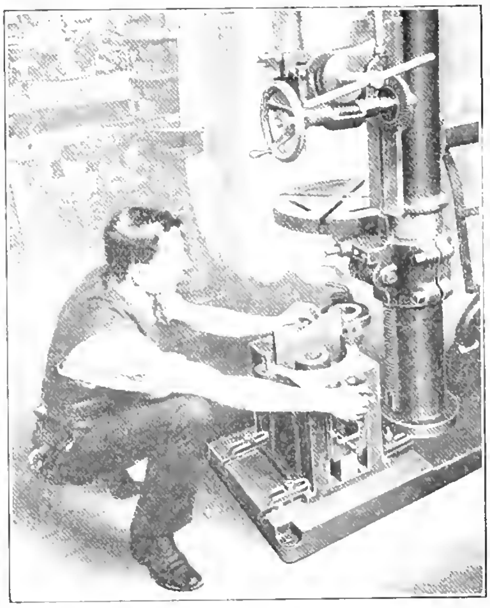


Fig. 16.

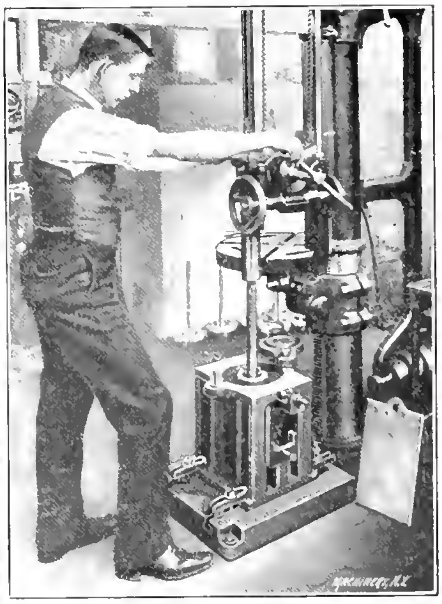


Fig 17.

Fixture for Boring and Reaming the Turbine Bearings

Fig. 17 shows the bearing being bored without the use of the guiding bushings, by means of a bar which runs in a step bearing at the base of the jig.

In connection with the oiling arrangements for the bearings, reference should be made to the design of the wheel casing in which the bearings are located. This casing is in two halves, divided on a horizontal plane, and the upper edge of the lower half has an oil groove running around it, as shown in Fig. 2, to catch any drip that may work in between the two halves. The oil is carried down into pockets in the casting, where the ring oilers reach it, and these pockets are piped to

of gaskets which have been cut out by this device. The gaskets used are about 1-16 inch thick, of asbestos board.

To the right of this gasket-cutting table appears a Pratt & Whitney measuring machine, which reads to one-half of .0001 of an inch by means of a microscope. This machine is employed in measuring gages and is not for shop use.

Fig. 13 represents a general view of the inspecting department. All parts which can be readily handled after being finished in the shop are brought here for inspection. They are accurately gone over by special sets of gages, to see that they are interchangeable. The large parts, such as gear and

wheel cases, are inspected out in the shop. After inspection, each piece is stamped with a designating mark, telling who inspected it, to locate the responsibility for any careless inspection. Every part of the turbine is also numbered in the inspecting department, the number being the same for the

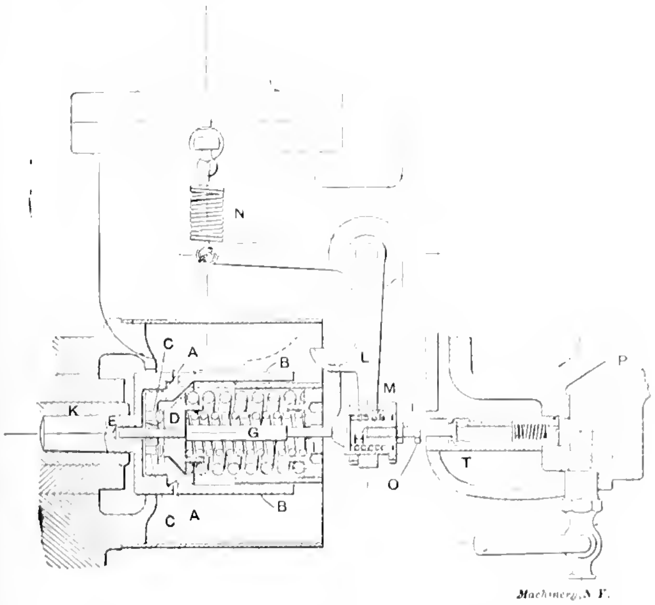


Fig 18. Details of De Laval Governing Arrangement.

same part in the various sizes of turbines, with a letter in front of the number to show the size of the machine. For example, L-429 would represent a 55-horse power gear body, the number "429" being the number of the gear body, and the letter "L" signifying the horse power, which is 55 in this case. The man shown in Fig. 13 kneeling is inspecting with a taper plug gage the hole for the gear shaft in the gear body, which in this case happened to be L-429.

Fig. 20 is a view of the pattern shop, and on the bench in the foreground is an interesting set of patterns used for molding one size of centrifugal pump runner. The particular wheel for which this set of patterns is made is about 21 inches in diameter and is to be used in connection with a 300-horse power pump running at 900 revolutions per minute. At *A* is a half core box inclosing a circular foundation plate on which is the pattern for the spirals located on the inside of the runner. A sweep at *a* is employed for sweeping up the core, which is afterward baked. This makes one-half the core for the inside of the runner; the other half is made on a similar base plate and pattern, shown at *B*. At *C* is the core box for the central hole through the runner, and at *E* is a pattern for one side of the runner, and at its center is the core print for the cylindrical core made in the core box *C*. Pattern *E*, and its mate for the other side of the runner, shown under it, are molded in the foundry, and then the three cores are placed in the mold in the usual manner.

The Governor.

Reference has now been made to most of the principal parts of the turbine, with the exception of the governor and throttle valve which it controls. These are shown in Figs. 18 and 19 respectively. The governor is held in the end of one of the gear shafts by the taper plug *K*, Fig. 18, and is made cylindrical in form, with its outer shell *B B* cut longitudinally into two halves which form the governor weights. These weights are fulcrumed at *A A* and have pins *C C* which press against a collar *D* which takes the thrust of the spiral springs located

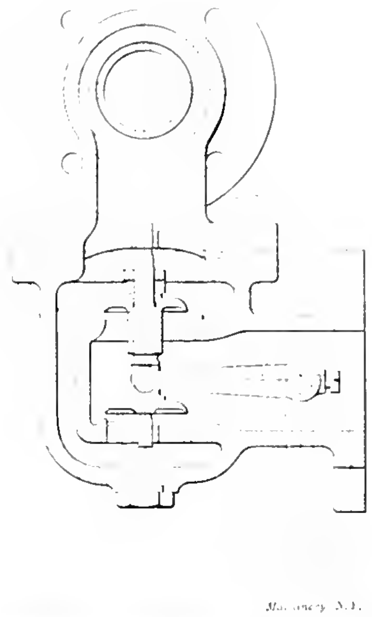


Fig. 19. Regulating Valve.

Fig. 20. View in Pattern Shop showing Patterns for a Centrifugal Pump Wheel

within the governor. The movement of the governor is transmitted through the center spindle G to the bell-crank lever L, which is balanced by a spiral spring N. The shaft supporting this lever passes through the valve casting on the inside of which are a pair of arms connecting with a double-seated throttle valve as shown. In the steam pipe above the valve is a wire cylindrical screen, to prevent any large particles of scale or other material likely to damage the turbine from passing through. It is to be noted that the connection between the center spindle G of the governor and the bell-crank lever L is a flexible connection, and that at the right is a valve T, which connects through the passage P with the wheel casing. In case the throttle valve should stick and the turbine speed go up, the governor would have power enough to overcome the pressure of the spring at the connection H, and the pin O would strike the spindle of the valve T, which latter would admit air to the vacuum chamber in which the wheel revolves. This would immediately put an air brake on the wheel and prevent an acceleration of speed. If for any cause the speed becomes excessive this action takes place.

* * *

WOOD PRESERVATION.

As timber becomes scarcer and more costly the importance of its preservation becomes greater. The decay of timber is principally caused by fungi, but bacteria and insects also play a part. Timber will not decay unless it be subjected to three conditions—air, moisture and warmth; if any one of these conditions is absent there can be no decay. Timber submerged under water so that air is excluded will not decay; neither will it decay if continually dry, or where the temperature is uniformly low. But in ordinary use timber is subjected to all three conditions which favor decay, hence the importance to railways of artificial processes for preserving cross-ties, bridge timbers, etc. The Association of Railway Superintendents of Bridges and Buildings in a committee report submitted at the Chicago meeting in October, outlined some of the methods of preserving timber as follows:

Creosoting.—The creosoting process makes use of dead oil of coal tar which is a distillate of coal tar, a product of the manufacture of illuminating gas. Green timber is subjected to a steaming process 200 to 250 degrees F. for several hours in a closed cylinder to liquefy the sap and to solidify the albumen in the cells. After steaming for some hours the cylinder is exhausted to a partial vacuum to expel the liquids from the interior. After this process is complete the cylinder is filled with dead oil of tar at a temperature of about 175 degrees F. and subjected to a pressure of 80 to 100 pounds per square inch to force the oil into the pores. This is sometimes called the Bethell process.

Burnettizing.—In the Burnettizing process the impregnating fluid used is chloride of zinc which is applied in a water solution similar in method to the creosoting process. After treating, the wood must be thoroughly dried to deposit the salt in the cells, but even when this is done exposure of the wood to water afterward will dissolve the salt and leach it away. While the process is fairly satisfactory for ties it is not good for structural timbers and has been practically abandoned by nearly all European railways.

Kyanizing.—In this process seasoned timber is soaked in a solution of bichloride of mercury (corrosive sublimate) which coagulates the albumen. The solution is very poisonous and corrodes iron and steel, hence is unsuited for structural purposes in which metallic fastenings are used. The process is effective, but dangerous to the health of the workers employed.

Wellhouse.—The Wellhouse process also uses zinc chloride as does the Burnettizing process but adds a small percentage of glue. After the timber has been treated under pressure the zinc chloride solution is drawn off and one of tannin is substituted. The tannin combines with the glue and forms an insoluble substance that effectually seals the pores.

Allardyce.—The Allardyce process makes use of zinc chloride and dead oil of tar, the latter being applied last, and the manner of application being essentially the same for both as explained with the other processes.

Boucherizing.—Sulphate of copper in solution is forced into the timber under heavy hydrostatic pressure. Sulphate of copper attacks iron and is, therefore, objectionable from a structural standpoint.

Thilmany.—Sulphate of copper is first used in the Thilmany process and then a solution of barium chloride, but the process has not shown good results.

Hasselman.—The timber is boiled in a solution of copper, iron and aluminum sulphate to which a small quantity of kainit is added. The results in Germany seem to show that the process is satisfactory.

Creo-Resinate.—In this process the timber is first subjected to a steaming process at 200 degrees F. to evaporate the moisture in the cells; the temperature is then gradually increased to 320 degrees F. and a pressure of 80 pounds per square inch. The pressure is slowly reduced to 26 inches vacuum, and then a solution of dead oil of tar, melted resin and formaldehyde is injected. After this process the timber is placed in another cylinder where a solution of milk of lime is applied at a temperature of 150 degrees F. and a pressure of 200 pounds per square inch.

Vulcanizing.—The vulcanizing process of treating timber consists essentially in subjecting it to a baking process in hot air which is heated to a temperature of about 500 F. by passing over steam coils. The heat coagulates the albumen, expels the water from the cells, kills the organisms therein and seals the cells by transforming the sap into a preservative compound. This method is used with success by the elevated railway systems of several cities.

* * *

A QUICK JOB.

The following interesting description of a quick piece of work in replacing a large iron pulley with a wooden pulley, and by this means averting a long shutdown of the plant where the change was made, has been sent us by the Reeves Pulley Company, Columbus, Ind.

On Thursday, October 6, the massive cast-iron main drive pulley, 112 inches diameter, 37 inches face, in the plant of Lafayette Box Board & Paper Co., Lafayette, Indiana, went to pieces.

President Bauer, of the Paper Company, and his superintendent, Mr. Wilson, appreciating the length of time required to get an iron pulley of this size in place, sent their men home, and announced a thirty-day shutdown. They did not know a wooden pulley of this size, and capacitated to handle 600 horse power, could be built, but later in the day Mr. Bauer was persuaded to 'phone Reeves Pulley Company concerning their trouble. The pulley company assured Mr. Bauer that they could furnish him a pulley of the size designated, absolutely guaranteed to carry the load, and the order was placed. Work was commenced on the pulley Friday morning at 7 o'clock, and within eighteen working hours it was completed and en route to its destination. The pulley, accompanied by Superintendent W. S. Jones of the Reeves Company, was taken by Saturday's midnight Pennsylvania Express to Indianapolis, where the Chicago Fast Express of the Big Four was held one hour in order that the pulley might be transferred, and this train in turn delivered it at Lafayette at 3 o'clock Sunday morning. The pulley was here met by a corps of workmen and Superintendent Wilson, who immediately transferred it to the paper plant, where under the direction of Mr. Jones, the installation was completed Sunday afternoon and on Monday morning at 6 o'clock the big mill started as usual.

* * *

A Custodis brick chimney 300 feet high is being built for the New York Steam Heating Company alongside the Manhattan approach of the Blackwell's Island Bridge. It is to have an outside diameter of 29 feet 6 inches at the base, tapering to 17 feet at the top. It will weigh approximately 2,160 tons and will cost $25,000.

* * *

By an error in the engraving, Fig. 1 of Mr. Geo. D. Hayden's letter, "Charts for Forming Tools," in the October issue, .208 was omitted from its place between .192 and .224 under "Given" at the top of the cut. Consequently the quantities to the left as far as the third division space (which was also omitted) are misplaced one space.

ADAMS-FARWELL AUTOMOBILE.

NEW FEATURES AND A NEW TYPE OF ENGINE.

The Adams Co., Dubuque, Ia., have brought out a revolving-cylinder, air-cooled, gasoline motor for automobile use, which possesses many points of novelty. It reverses the ordinary practice, in that the engine cylinders revolve and the crankshaft, which is in a vertical position, remains stationary. The motor is the invention of Mr. F. O. Farwell, superintendent of the Adams Company, and its details have been very carefully worked out during the process of development at the shops of this company. The motor has been tested for a long period under trying conditions and we are informed that its performance has proven satisfactory to its inventor and to the builders, and that it is now placed on the market with the assurance that it will meet any demands that may reasonably be made upon it.

Fig. 1. Automobile with Convertible Front Seat. The Machine can be Controlled from either Seat.

The engine consists of three units, each made up of cylinder, piston, connecting rod, etc. The cylinder castings are bolted together, forming a single rotary element, which acts as a flywheel and is in nearly perfect balance. In a 20 horse-power engine, such as is now built for automobiles, the cylinders have 5-inch bore, the pistons $4\frac{1}{2}$-inch stroke, and the revolving unit, consisting of the three cylinders, pistons, and their connections, weighs only 190 pounds.

The cylinder castings are bolted to a top and bottom cast steel flange which has bronze bushings serving as bearings for the vertical stationary crankshaft. The three pistons are connected to a single crankpin of large proportions by bronze pitmans. Inasmuch as the pistons and cylinders are rotating about different centers, the pistons reciprocate back and forth once during each revolution of the engine.

The light weight of the motor, compared with the usual three-cylinder motor, is brought about by the elimination of many parts found necessary in the engine of the ordinary type. A single central crank case answers for the three cylinders. A single-throw crank, of about one-third the weight of the three-throw crank found in the other type of engine is employed. A single cam operates both inlet and exhaust valves for all the cylinders. Although the engine is light in weight, the rotating parts constitute a flywheel of unusually heavy weight which is conducive to steady running; and the facts that the engine is in so nearly perfect balance and runs on a vertical axis nearly eliminate vibration and adapt the motor especially to automobile driving.

It was determined by experimenting with the engine that the exhaust muffler of the design usually employed could be dispensed with. This is because the rotating cylinders seem to run away from the exhaust gases, as it were, and this action was found to reduce the noise incident to the escape of the burnt gases. The exhaust noise partakes more of the character of the noise of a skyrocket than of the report of a gun. Auxiliary exhaust ports are employed which reduce the pressure before the gases finally discharge to the atmosphere, and we are informed that at low power the exhaust is noiseless, while at full power there is less noise with this system than in the case of an engine of the usual construction working at full power.

Another unlooked-for result brought out in experimenting with the engine was that centrifugal force served to close the valves and that this force was in direct proportion to the requirements. The higher the speed the greater the force and the greater the need for a stiff spring or force to open the valve. The springs actually used are made of light piano wire and are useful only to close the valves in starting the engine when the centrifugal force at the slow starting speed might not be sufficient to overcome the resistance of cold lubricating oil on the valve stems. After the engine is started and has become warmed up the springs are not needed.

One of the most advantageous results of the moving cylinder principle is the effective air cooling accomplished. The cylinders are cast with longitudinal external ribs, to provide a large radiating surface and their rapid rotation draws in the air at the center of the casing which incloses the engine and expels it with a considerable velocity at the periphery, or ends of the cylinders. The air is continuously in contact with every part of each cylinder, and there can be no hot spots in the cylinder walls due to unequal circulation of the air, such as is effected by a fan driving the air against only one side of a cylinder or group of them. The cylinders are found to keep cool and work well in warm weather, and there is nothing to freeze in cold weather.

The foregoing briefly summarizes the most prominent features of the new motor, resulting from the rotating cylinder construction. The inventor has carefully worked out other features, however, which, although they could be applied to engines of other forms of construction, seem to be of quite as great interest to the automobilist as the details already outlined. First of these in importance is that the speed of the motor is controlled by a variable compression system. Ordinarily the speed of an automobile equipped with this engine

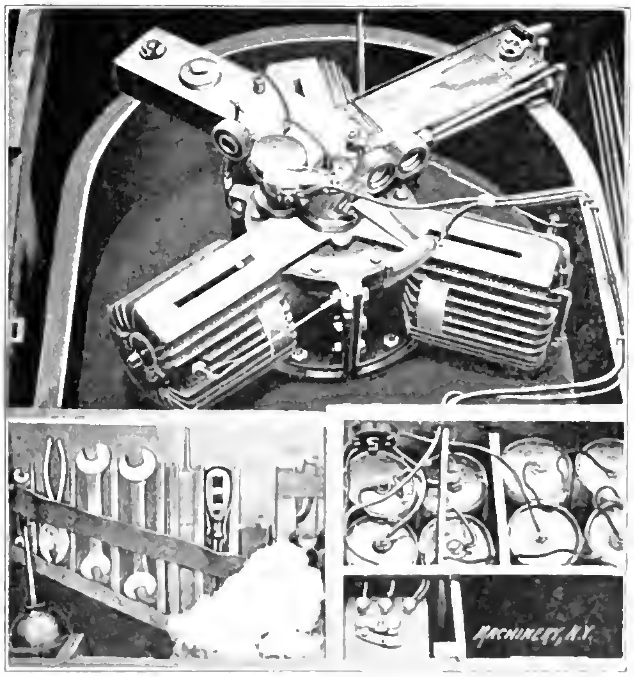


Fig. 2. View of Motor, with Rotating Cylinders, showing it in position in the Vehicle.

may be controlled by changing the speed of the motor, just as in a steam engine; but a speed gear is provided that can be used to pull the machine out of a rut or in climbing an exceptionally steep hill, if found necessary. In the compression system used that part of the charge not needed to give the motor the required power is allowed to escape back by the inlet valve, which is mechanically held open for a part of the compression stroke; that part of the charge so escaping being drawn in by another cylinder. The mechanism is so designed that that part of the charge rejected by any cylinder is first used in the succeeding cylinder, before additional gas is

drawn through the carbureter. There is therefore no waste of gas. When the maximum power is required the inlet valve is closed at the end of the suction stroke and the full charge is compressed to about 95 pounds per square inch. When minimum power is wanted, the inlet valve is not closed until the completion of the compression stroke, and an exceedingly small part of the charge is retained and ignited at atmospheric pressure, giving a gentle expansion.

With this system of control the chauffeur has nothing to do with the point of ignition of the charge by the spark. Instead, the spark is controlled automatically by a device connected with a centrifugal governor and fires the charge at the point producing the highest efficiency at all speeds. It also automatically changes the length of contact of the primary circuit for different speeds, with a view to saving the battery current and contact breaker points. At a speed of 150 revolutions or less the contact is for a period occupying 1-36 of a revolution of the engine; and for a speed of 900 revolutions, the period is during 1-12 of a revolution.

The carbureter is also entirely automatic at all speeds, no attention being required after once adjusting. The proportion of air and gasoline always remains the same, but the quantity of the mixture varies according to the power required and the position of the variable compression cam.

The oiling of all parts of the motor is cared for by a positive-feed oil pump. This consists of a circular barrel in which are four cam-actuated plungers. The barrel is positively driven by a worm gear and will deliver one drop of oil to each of four tubes, carrying the oil to different parts of the engine every 100 revolutions. Two of these tubes lead to a distributing channel in the upper end of the crankshaft and oil the top of each cylinder; one tube leads to the upper end of the wristpin and from thence to the lower crankshaft bearing, a surplus accumulating in the crankcase, which lubricates the valve-operating cams and gears. An opening on each side of each cylinder admits oil from the crankcase to the cylinders, thus oiling each cylinder and piston at three equidistant points. The fourth tube is an extra, and usually is turned to deliver its oil back into the tank. The tank is close to the engine where it is kept warm in the winter time.

Fig. 2 is a view of the motor as situated in the rear of an automobile body. From this position every part of the motor liable to require inspection is readily accessible and exposed to view. Also, the tools required for adjustments, the batteries, spark coils, etc., are all close at hand. In Fig. 1 is shown one of the latest designs of automobile body used by the Adams Company. The fact that the motor is located under the seat makes it possible to adopt the style of convertible carriage illustrated, by which a second seat in front is available in front of the main or fixed seat. The sides and top are removable, and the motor and car can be controlled from either the front or rear seat. The novel features of the car and motor are subjects of patents granted or pending in this and foreign countries.

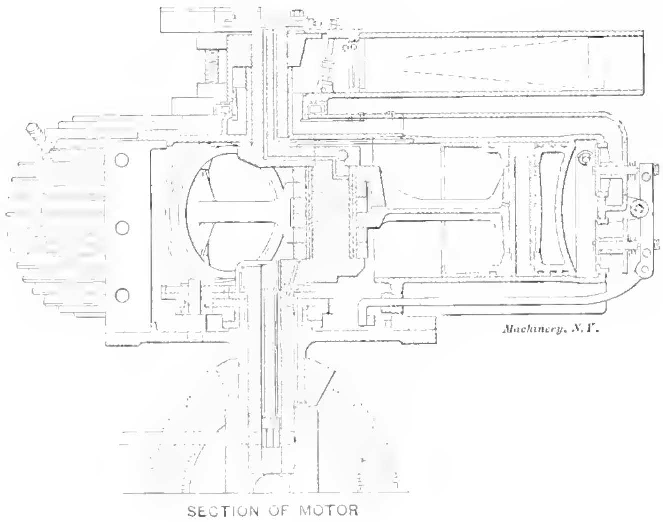


Fig. 3 Sectional Elevation of Engine.

A MODERN PATTERN SHOP AND ITS SYSTEM OF HANDLING PATTERNS.

The new pattern building of the B. F. Sturtevant Co. at Hyde Park, Mass., is divided midway of its length by fire walls inclosing stairs, elevators, etc. One-half the building, with stories respectively 17 and 15 feet, is devoted to the flask and pattern making rooms, while the other half, provided with intermediate floors, making four in all, is utilized for pattern storage. An illustration of the exterior of this pattern building has previously appeared in these columns in connection with a description of the new Sturtevant foundry.

Fig. 1. View in Flask Shop.

The flask-shop measuring about 60 feet by 80 feet is equipped with band, cross-cut and splitting saws, boring machines and lathe, all driven by a 10 horse power Sturtevant motor suspended from the ceiling. The industrial railway runs directly into this room from the foundry, across a distance of about 40 feet and together with an overhead transfer track reduces to a minimum the cost of handling flasks. The lumber for their manufacture is unloaded from cars directly in front of the building. This room includes the metal patternmaker's department equipped with the necessary machine tools. Adjacent thereto is the locker, wash and toilet room for the building.

Immediately above is the pattern shop, abundantly lighted upon three sides and equipped with a full complement of tools. All the power machines are operated by two 10 horse power Sturtevant motors, both being required for ordinary work, but one always serving as a possible relay in case of accident.

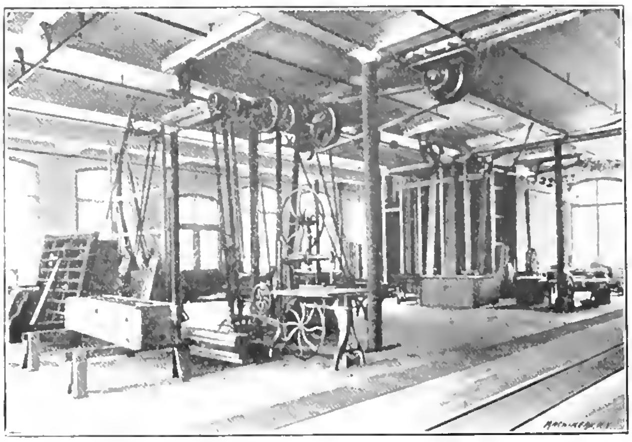


Fig. 2. Pattern Shop.

The benches which accommodate two men each and measure 2 feet 6 inches in width by 16 feet in length are so arranged along the sides of the building that the men all receive a left-shoulder light. Behind each bench is a working table 4 feet wide by 16 feet long. The benches are supported by cast iron legs of special design which were built by the Sturtevant Co.; the same design is used throughout the plant. They are equipped with Emmert vises and their tops are of heavy maple plank. A drying chamber for glued work is provided which receives warm air through the general heat flue from a Sturtevant heating apparatus below.

The first floor of the pattern storage end of the building is of concrete and is designed for the keeping of heavy cast iron patterns. It is served by an industrial railway and turntable which permits of transfer to the elevator and thence to other floors. Communication between the pattern shop and storage department is direct, while the fire risk is reduced to a minimum by a double system of fire doors. Around the pipe columns which support the floors are clamped the pattern shelving brackets which are adjustable to any height. Shelves on the walls afford excellent storage space for the smaller patterns.

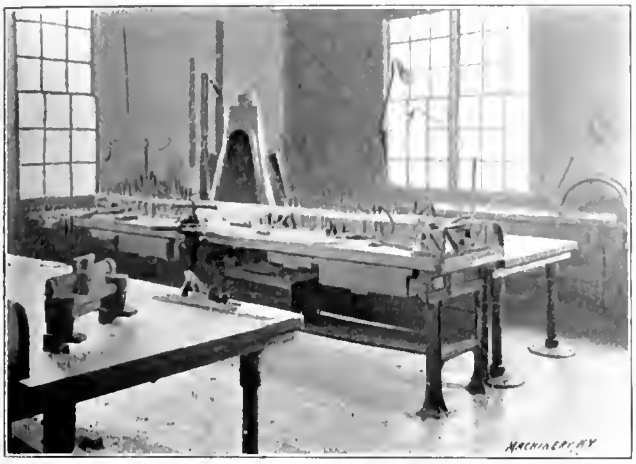


Fig. 3. View of Pattern Shop, showing Benches.

In connection with a description of this shop, the system of handling patterns is of interest. New patterns are numbered consecutively upon the drawings as made. Patterns for gray iron castings take a number without prefix. Patterns for brass castings take a number preceded by 0, those for steel have the number preceded by 00, and so on with a different prefix for each material. The numbers are taken out by the draftsmen in a blotter having columns for data, pattern number, name of pattern and drawing number. This record is afterward transcribed into the "Pattern Record" book by the record clerk in the drafting room.

Fig. 4. Pattern Storage Room.

At the time of taking out a new pattern number a pattern cost card is filled out. This is sent with the drawings to the foreman of the pattern shop and is an order for him to make the pattern described. The time is kept in the pattern shop and entered on this card, as is also the record of stock used. When the pattern is completed, it is inspected by the pattern shop foreman who signs cost card and enters date completed. The pattern is then sent at once to the pattern storage, which is under the supervision of the pattern foreman, and the pattern cost card is returned to the drawing room by the next messenger. The record clerk in the drafting room figures the total cost of the pattern, writing on the card the cost of the labor, stock, etc., and giving the totals. The card is then filed away according to its number. When any work other than pattern work is done a record is kept of the time and material and the pattern shop is given credit. These records give the amount of material and labor chargeable to expense, to which are added a depreciation and fixed charges. The whole is then distributed as a percentage on the hours of pattern labor.

When the patterns are delivered to the pattern storage department proper locations are assigned and records thereof made upon cards, one for each pattern. These cards are filed in the order of the pattern numbers. Four figures, with the addition of a letter, are in every case sufficient to locate a pattern. A given location, for instance, may be 2125B; that is, it is upon the second floor, as shown by the first numeral "2;" it is in the twelfth row of shelves and the fifth division of that row, as shown by the succeeding numbers "12" and "5;" and on the B level, the floor level being designated A and the letters B, C, D, etc., indicating the shelves in their order above.

When the foundry foreman receives an order for castings from the office he issues an order to the pattern storage department. The pattern storage keeper on receipt of same refers to a card index of patterns giving the location of pattern desired. The foreman's order is then attached to the pattern and delivered to the foundry. A metal clip placed upon the card in the card index belonging to the pattern sent out, indicates the pattern is out. When the casting order reaches the foundry a copy is sent to the clerk of the cleaning room, who daily records on the back the number of good and bad castings made from the pattern and keeps the molder informed as to the number of castings required to complete the order. When the required number of castings are made the pattern is returned to the pattern storage, and the metal clip taken from the index card.

* * *

LARGE MECHANICAL DRAFT FAN.

In the September number was published a contribution describing the large ventilating fan of the Albespeyre Tunnel of the Langogne-Alais line running between the Atlantic and Mediterranean. This called forth a communication from the Garden City Fan Co., of Chicago, in regard to a large fan for a mechanical draft plant of 500 H. P., showing that the latter is larger than the foreign article, and that we are still sustaining our boasted reputation for big things. The Garden City fan is 20 feet in diameter by 9 feet wide at the

Fan Twenty Feet in Diameter for Mechanical Draft Plant.

periphery, whereas the Albespeyre fan is 6 meters, or 19.7 feet, while the width is 2.5 meters, or 8.2 feet. The weight of the American wheel is 5 tons without the shaft, which is 9 inches in diameter and with its coupling weighs 4500 pounds, making a total weight of $7\frac{1}{2}$ tons on the journal bearings. The fan wheel was incased in a $\frac{3}{4}$ housing of steel measuring 36 feet from the bottom of the bed to the top of the housing, and 26 feet in length. The illustration herewith is from a photograph taken of the fan when in the process of erection in the factory. It is believed by its makers to be the largest fan ever built.

THE HAMILTON-HOLZWARTH STEAM TURBINE.

It has been known for some time that the Hooven-Owens Rentschler Company, Hamilton, O., were developing a steam turbine and that one was being built by them for the St. Louis Exposition. This first machine is now in operation and is direct-connected to a 1,000-kilowatt Bullock generator. The turbine is of the compound impulse type in which there is a series of impulse wheels, each wheel in a separate compartment and driven by jets of steam directed against the wheel buckets by suitably-shaped guide vanes.

The illustrations herewith give a general view of the turbine and show some of the features of construction. For units of 750 kilowatts and upward, the rotating body is divided into two parts, the high- and low-pressure turbine. Smaller turbines are built with the parts inclosed in a single casing. The turbine casings and pedestals for the bearings and the generator are mounted upon a single bedplate, and all steam, oil, and water piping, including the steam inlet, are within and below the bedplate. The steam enters through a separator and passes through the main inlet valve and the regulating valve, all below the bedplate, to the head of the high-pressure turbine. From the steam channel of this head the steam flows through the first set of stationary vanes, forming a complete annulus of steam channels, which direct the steam at the proper angle against the wheel blades, and allow the steam to expand to the lower pressure in the compartment in which the first wheel rotates.

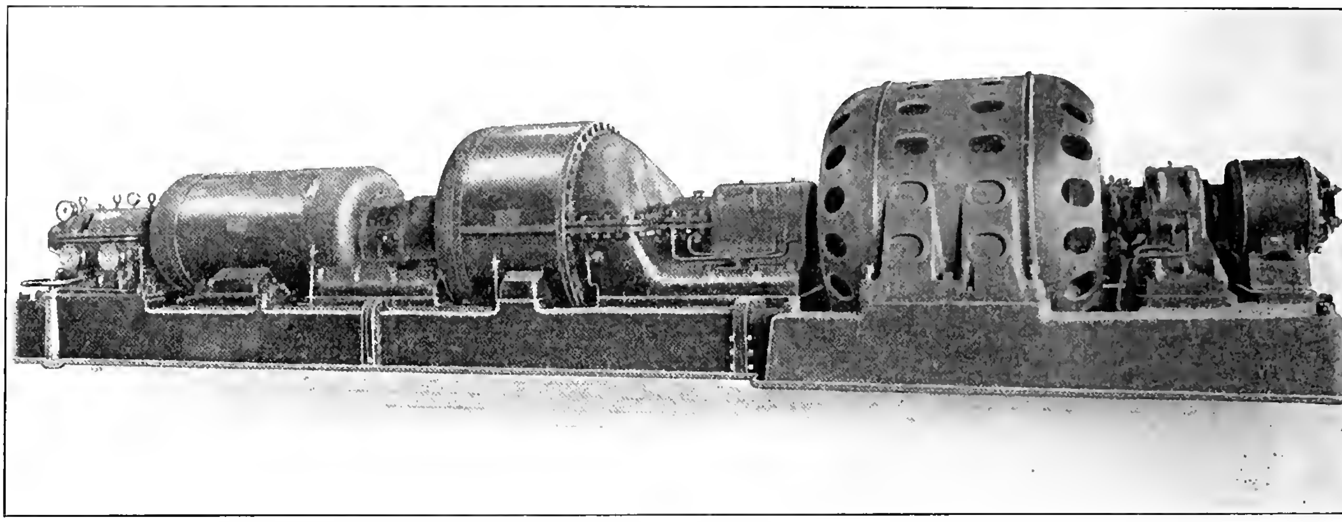


Fig 1. One Thousand K.W. Steam Turbine built by the Hooven, Owens, Rentschler Company, Hamilton, O.

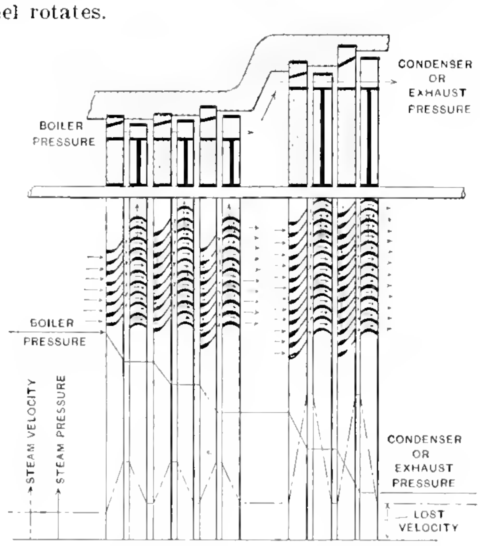


Fig. 2. Diagram showing Principle of Turbine.

From the last running wheel of the high-pressure turbine the steam is led through receiver pipes to the front head of the low-pressure casing, or if there is only one casing, immediately to the condenser. In the low-pressure turbine the steam is distributed in the same manner as in the high-pressure turbine. The low-pressure front head, however, has an additional nozzle through which live steam enters for use in case of overload. The design is such that this steam, which is controlled by the governor, exerts no back pressure upon the steam from the high-pressure turbine. On the contrary, it works like an injector, sucking the steam through the first stationary vanes of the low-pressure turbine. The disks of the low-pressure turbine have guide vanes all around their circumference, as in the high-pressure turbine, and the steam flows through them in a full cylindrical belt, interrupted only by the guide vanes.

The scheme of the turbine and the action of the steam are illustrated in the diagrammatic sketch, Fig. 2. The steam passes through the turbine in the direction indicated by the arrows. The smaller diameter at the left represents the high-pressure turbine, and the larger diameter at the right the low-pressure turbine. The stationary vanes in each disk gradually increase in height, while the vanes are made higher in the successive wheels to accommodate the increasing specific volume of the steam. The wheels receive no unbalanced steam pressure in an axial direction, because the impact of the steam upon the buckets and its reaction in leaving the buckets are equal. If, as in the Parsons turbine, the steam acquired additional velocity in passing through the wheel channels by expanding in these channels, the reaction would be greater than the impact, which would produce an end thrust. In the Hamilton turbine the pressure is the same on both sides of each wheel. The diagram in the lower part of the sketch shows the changing steam pressure and steam velocity so plainly as to need no further explanation.

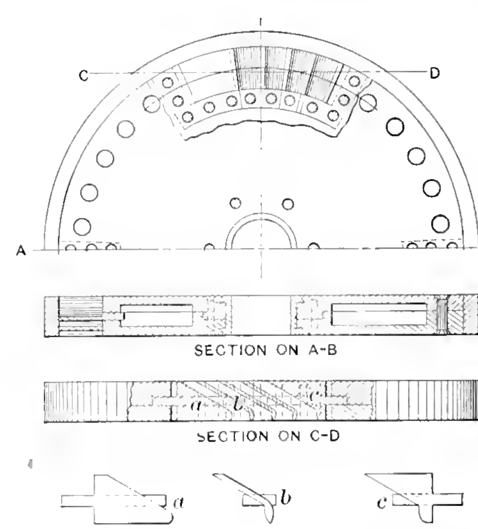


Fig. 3. Details of Stationary Disks and Guide Vanes.

In Figs. 3, 4, and 5 are shown certain details of construction of the turbine. Fig. 3 illustrates the features of the stationary disks, which are built up of two side pieces riveted together. Each vane is a separate piece held by a projection

at its lower end, which fits in an annular groove between the two disks at their periphery. The vanes are of drop-forged steel and are secured by rivets. After they are in position, their outside ends are ground and a steel ring is shrunk on. At *a*, *b*, and *c* are shown three forms in which the drop-forged vanes may be made. In the turbine, as now constructed, however, the vanes extend around the whole periphery, so that the type shown at *b* is the only one required.

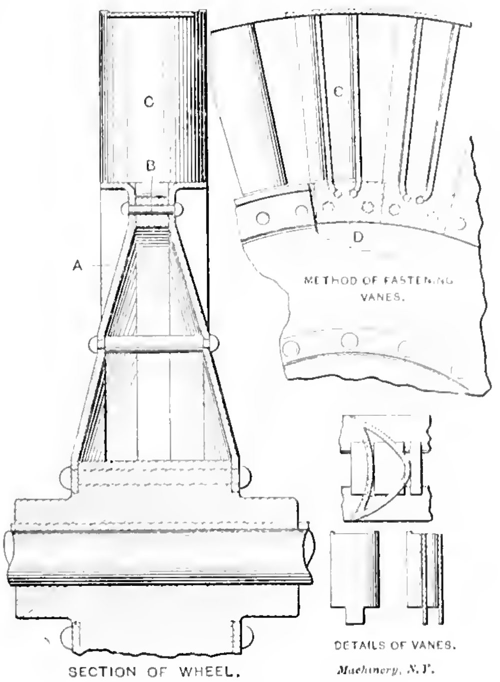


Fig. 4. Details of Turbine Wheel.

Next in importance to the guide vanes and the disks which hold them, is the construction of the rotating wheels, in Fig. 4. These wheels are as light as possible, with cast steel hubs to which are riveted conical disks *A*. There is a space between the disks at their periphery in which are riveted short steel segments *B*. The vanes are attached to these segments, as shown in the sectional view at *D*. The vanes are formed with lips extending downward, and these lips are enlarged at their ends to fit into the enlarged bottom portions of cross channels in the segments *B*. The vanes are so designed that the passages through the wheels have a uniform area from beginning to end, and they are made hollow to reduce their weight. On the outer ends of the vanes a thin steel band is shrunk to give an outside wall to the steam channels. The vanes are milled on both edges to give correct influx and efflux angles.

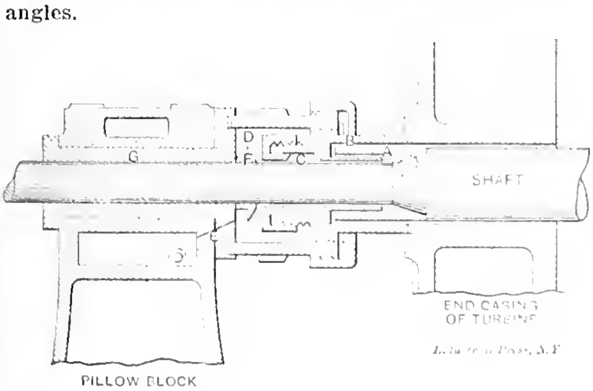


Fig. 5. Gland and Bearing for Shaft.

At Fig. 5 is a sectional view of the bearing and stuffing box for the shaft at the point where it passes through the end of the turbine casing. The shaft is turned to a smaller diameter at its end and runs in a bushing *G*, having a flange bearing against the inner side of the pillow block. At *A* is a cylindrical piece attached to and rotating with the shaft. This piece projects into an annular groove in the piece *B*, but it does not completely fill the groove and a circuitous passage is formed through which the steam must pass before reaching the stuffing box *C*. The object of the passage is to provide condensing surface so the steam itself will not reach the packing. The joint at the stuffing box is thus practically a water-locked joint.

To prevent the oil from working into the turbine a bushing *F* is attached to the shaft which throws off the oil into the space *D* by centrifugal force, where it drips down through a channel *E* into a compartment in the pillow block. Any water escaping through the stuffing box is also collected in the same compartment. The bearing is oiled by a forced oil system, the oil being supplied to the bottom of the bushing.

The high-pressure and low-pressure turbines each have a separate shaft connected by a flexible coupling, and the generator also has its own shaft driven by the turbine through a flexible coupling.

The couplings are a modified form of the familiar disk coupling, having clutch teeth projecting from the face of each disk. The teeth in this case, however, are laminated, which gives them both the necessary strength and flexibility. They are built up of thin steel plates, and the laminated teeth of one disk fit in the spaces between corresponding pairs of teeth in the mating disk.

The governor is of the spring and weight type, adapted to high speed, and controls the turbine by throttling the steam. The throttling takes place at a single balanced valve instead of at the nozzles in the first disk. The governor is constructed on a relay system on the following plan, illustrated in Fig. 6.

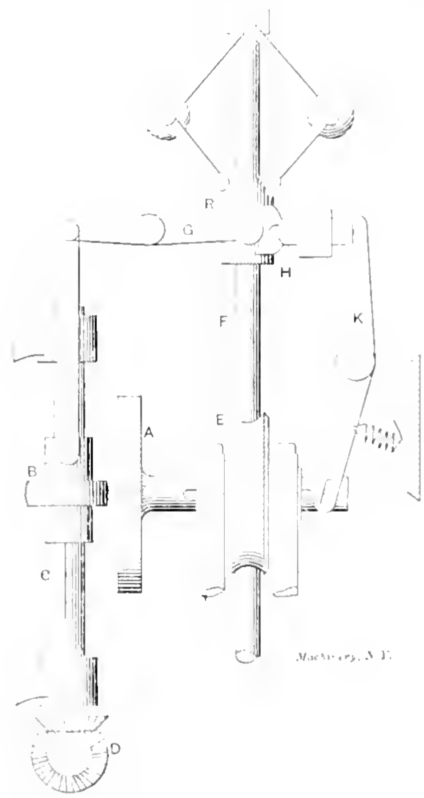


Fig. 6. Diagram of Governor Mechanism.

The regulating valve is controlled by means of a friction disk drive, in which the edge of a small disk or roller is in contact with the face of a continually rotating disk. This disk is driven by a worm and wormwheel from the shaft which operates the governor. In the illustration, *A* is the friction disk, *B* the roller, *C* the splined shaft with which the roller turns but upon which it is free to slide; *D*, bevel gears connecting shaft *C* with the throttle valve; and *E*, a wormwheel driving disk *A* by means of a worm on shaft *F*. At normal speed the governor sleeve is in mid position and roller *B* is at the center of the disk. If the turbine speeds up, however, the governor sleeve will rise, carrying with it the right-hand arm of lever *G*, which will move the roller *B* a corresponding distance downward. At the same time the cam *H* will be thrown to the right by contact with the roller *R* upon the governor sleeve, and this, by means of lever *K*, will move the disk *A* and its shaft to the left in contact with roller *B*, thus imparting a rotary motion to the shaft *C* and closing the throttle valve the necessary amount to bring the speed of the tur-

bine back to normal again, when the several parts will assume their first position. If the speed of the turbine decreases, the action of the mechanism will be entirely similar, except that the roller *B* will be raised instead of lowered and brought in contact with the friction disk at a point above its axis. The disk will therefore rotate shaft *C* in the opposite direction, opening the throttle valve instead of closing it as before. Other features of the governor are that when the angular velocity of the turbine reaches a point $2\frac{1}{2}$ per cent. higher than normal, the governor shuts off steam entirely. Also if the angular velocity falls below a certain percentage of the normal speed, the friction disk is drawn back so that the valve-operating part of the mechanism is inoperative. The methods of accomplishing these results are not shown in the sketch.

This turbine is known as the Hamilton-Holzwarth steam turbine. It is made under patents of Hans Holzwarth, assignor to the Hooven-Owens-Rentschler Company.

* * *

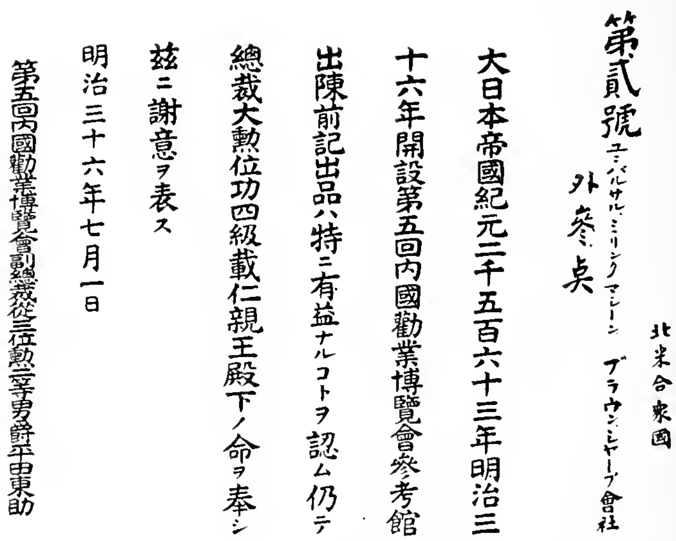
CHAIN DRIVE IN A RUBBER MILL.

The conditions of power transmission in rubber mills are probably as severe as found in any class of manufacturing, save perhaps in rolling mills. The nature of the work is very intermittent, causing sudden shocks on the transmission gears; the machines may at one moment be taking the maximum power requirement and in a few moments the power requirement decreasing to zero. For this reason the use of chain drive in the works of the Vulcanized Rubber Co., at Morrisville, Pa., is of much interest because of the severe duty imposed upon it. A prominent mechanical engineer of New York city who rebuilt these works some two years ago, investigated the merits of chain drive and finally adopted the chain manufactured by the Morse Chain Co., of Trumansburg, N. Y., as the one he considered best for the particular service in view. It was used for transmitting power from the main shaft to the line shafts, for transmission from electric motors to line shafting, and to individual machines and tools. The main shaft in the old mill was driven by a spur gearing direct from the engine as is the usual practice in rubber mills, on account of the necessity for a positive drive. In the new mill, however, it was desired to get rid of this method of driving on account of the noise made by the gears, and because clear alleys on each side of the rubber rolls were desired. Moreover, it was desired to group all the engines in one engine room. The plans called for two independent 200 horse-power Corliss engines driving a jack-shaft, and thence the main line of shafting. One engine was a relay to be used in case of breakdown or during repairs. To drive through belting, while possible, was not done because at least 24-foot centers would be required which would make necessary a larger engine room. The reduced center distances possible by the use of chain drive enabled the floor space in the engine room to be reduced some 750 square feet, which amounted to a saving in the cost of the building of $1,000, making the net saving between the cost of the chain and belt drive about $500 in favor of the chain. One engine is connected to the jack-shaft, which is distant from the fly-wheel shaft 7 feet center to center, and which carries other sprocket wheels for connection to the auxiliary engine some 10 feet away. In case one engine gives out, the driving chains are uncoupled and placed on the other sprocket wheels so as to drive with the auxiliary engine. The jack-shaft is connected to the main shaft with Morse chain running on 14-foot centers, making the total distance from the engine to the main shaft about 21 feet. These chains run about 1,150 feet per minute and after a year of constant service, show practically no wear on the rocking joint surface. Besides the main chain drive there are 40 motor drives operating principally individual tools in connection with the work in the factory, and a few of them driving blowers and pumps. The engineer reports that the cost of individual drives from the motors is more with the chain than for leather belting, but that the chain has most decided advantages on account of its positive speed ratio, less space required, shorter center distances, higher efficiency, and greater durability. The efficiency claimed by the makers for a chain is about 99 per cent., and, under the conditions found, the engineer could hardly have expected to have obtained an efficiency of much over 94 per cent. with leather belting. Hence he calculates that the increased cost of the chain drive will be more than offset by the saving in power alone, to say nothing of the other advantages just enumerated.

* * *

A JAP DIPLOMA.

The cut below is a reproduction of a diploma, written in the Japanese language, which the Brown & Sharpe Mfg. Co., Providence, R. I., recently received for an exhibit of some articles of their manufacture which they had at the Japanese Exhibition. The translation of the Japanese characters is as follows: "We, by the order of H. I. H. the Prince Kotohito,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ユニバルサル、ミリングマシーン
外参点
北米合衆國
ブラウン、シャープ會社
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明治三十六年七月一日
第五回内國勸業博覽會副總裁從三位勳一等男爵平田東助

A Jap Diploma.

President of the Fifth National Industrial Exhibition of Japan, hereby express our thanks for the valuable display of the above mentioned articles, which proved to be special object lessons to our people, in the Foreign Samples Building of the Fifth National Industrial Exhibition held in the 36th year of Meiji." (Signed) Baron Tosuke Hirata, Vice-President of the Fifth National Industrial Exhibition.

* * *

Photography is one of the most valuable means of record, and its use for this purpose is extending into all departments of engineering and mechanical work. A photograph tells its story at a glance, and when dated and supplemented with written notes a series of views makes the best possible record of progress. The cost of making photographs with a proper equipment is not a great expense, and any bright young man can learn to make exposures, develop the negatives and make the prints, in a few days. Some large shops use the camera extensively to show the rate of progress of work, the pictures being taken every few days. To insure accuracy as to the dating it is a practice to set up a small blackboard in the foreground with the date chalked in large letters thereon. Whenever a special job is done a picture should be taken of the set-up of the machine, and of the successive steps taken in the operation. It will often be of material assistance afterward to be able to show just how a certain job was done and what tools were used. In a case of accident or breakdown a record may be of great value, and cases are known where a good picture has been the principal and deciding evidence in a damage suit. With a high-grade lens tracings can be photographed in greatly reduced scale without distortion, and prints made from the negatives may be used in the shop much more conveniently than the large cumbersome blueprints. Lines and dimensions, although of microscopic size, will stand forth with great distinctness even though the tracing is photographed to a scale, say, one-sixth or less of the original size. In fact the usefulness of the camera in the average shop is only limited by the enterprise of those responsible for its application.

CURRENT ITEMS.

The seventh session of the International Railway Congress will be held at Washington, D. C., May 3-14 inclusive. This congress is composed of eminent railway men of all countries, and it meets only once in five years. The coming meeting at Washington will be the first ever held in this country, and it is expected to be of great interest, because of its international scope and representation to American railway men. Unusual efforts will be made by the American committee in charge of the arrangements, to make the meeting a successful one in the matter of exhibiting American railway appliances. The opportunity is one never before experienced by American railway manufacturers for the exploitation of their wares before so many representatives of foreign railways, who are eager to become acquainted at close range with American railway practice. The secretary of the American section of the International Railway Congress is Mr. W. F. Allen, 24 Park Row, New York; the secretary of the committee having charge of the exhibit of railway appliances is Mr. J. Alexander Brown, at the same address.

A meeting of the committee appointed by the American Society for testing materials on standard specifications for iron and steel was recently held in this city. Every step toward the adoption of engineering standards is to be commended, in view of the great convenience of such standards to engineers engaged in constructive work. We think no one would advocate carrying standard construction to the point where individuality would be eliminated. That this point would ever be reached is quite improbable, however, since it has been only with great effort on the part of a few enthusiasts that we now have such few standards as screw threads, pipe threads, etc., and standard methods of testing engines and boilers. Practically the only standard in engineering work up to date is the one adopted two or three years ago by the engine builders and electrical engineers for direct-connected generators, and as far as we know this has not come into very general use.

It is even more important to have standard specifications for materials of construction, upon which safety of life and limb depends, than for any other branch of engineering work. The committee having the matter in charge has already decided upon certain standards for test pieces after conferring with the committee of British engineering standards who are working along the same lines. The investigations of the committee and their recommendations are to extend also to the importance of standard specifications for structural material.

The West Side Young Men's Christian Association of New York City is now offering a course in Advanced Machine Design. This is not merely a course in drawing, but a thorough course in designing. To any young man residing in or near New York City, the course which the association offers will be a rare opportunity. It will consist of the working out of a number of problems, chosen in such a way as to be as helpful as possible to each student. These problems will be worked out by the students just as they would be in a regular drafting-room. Rules and formulas will be used in determining the dimensions of the various parts of the machines. Formulas will be taken, as far as possible, from the standard handbook, such as Kent and Suplee. Only such theory will be introduced into this course as is necessary. This work is intended for men who have not had a technical education, and will be made very practical in its character. The course will not be as extended as in a four-year technical school, but the work will be of inestimable value to men who desire a working knowledge of machine design, at a minimum expense of time and money. Only a nominal tuition fee will be charged. Professor Amasa Trowbridge of Columbia University is to have charge of the work. He is an engineer of wide experience, as well as an able instructor. Each student will receive personal instruction, and, as a knowledge of drawing is required for admission to the course, very rapid progress should be made.

LAUNCHING OF THE CONNECTICUT.

The United States battleship *Connecticut* was launched at the New York Navy Yard, September 29, in the presence of a vast throng of invited guests in the yard, and of a greater multitude on the surrounding piers and every point of vantage from which a view of the vessel could be seen; the promenade of the new Williamsburg Bridge was crowded from shore to shore. She is the first battleship to be built by the Government in several years, and is the largest built by any government to date. The *Connecticut*, with full equipment, will have a total displacement of 15,000 tons, and she and her sister ship, the *Louisiana*, now building at Newport News, will be the two heaviest battleships afloat. The launching was a complete success, passing off without hitch of any kind. The launching ways were greased with 8,500 pounds of tallow, which had been carefully boiled and filtered to remove all grit, to the end that the immense steel hull weighing 6,800 tons should encounter the least possible resistance during its movement into the water. The *Louisiana* was launched by the Newport News Shipbuilding Company some weeks before, and there is a great rivalry between the Navy officials and the private concern to see which can turn out a completed ship first. The outcome will to a large extent affect the future of battleship building in the navy yards. If it is shown that, working under the handicap of an eight-hour day, the navy yards can build battleships as quickly and cheaply as the private concerns, it is probable that most of them will be built by the Government in the future. The large and finely-equipped machine shops of the New York Navy Yard, costing over a million dollars (described in the July, 1902, issue of MACHINERY) were erected for the express purpose of building marine engines and other equipment for new naval vessels. The *Connecticut* is the first vessel built since the new shops were completed.

Further announcement is made of the progress of the work of the committees in planning the Carnegie engineering building. The programme of competition given to competing architects outlined that the auditorium, which is a central feature of the building, should have such capacity only that the voice of an orator or speaker should be distinctly heard in every part of it. It was considered useless to make the auditorium so large that discussions by untrained speakers should become merely a dumb show of moving lip and gestures. It was finally decided that an ordinary speaker could be heard if the audience did not exceed 1,000 on the floor, with the possible addition of 500 in a gallery. There are also to be smaller auditoriums having a capacity of 250 and downward, for monthly reunions.

The main auditorium is to be on the street floor and above this and the smaller meeting rooms will be the office floors, one for each of the societies, with reception rooms, etc. Above these there may be additional floors, if the funds are sufficient. On the top floor which will probably be the twelfth floor from the street will be located the consolidated libraries and the reference and reading rooms. Thus located in the building it will not only be more quiet, but it will be in the better air, above the fly line and will be lighted from the roof. Already the societies are taking up the question of organization and management of the building after its completion.

The engineers' club, which is to occupy a building adjoining that of the three engineering societies, and is to form the social part of the organization, will manage its own building independently as soon as it is completed

* * *

Marine propeller wheels are made right- and left-handed, and the direction of the helix corresponds to that of right- and left-handed screw threads. In other words, the top of a left-handed propeller wheel turns over to the left as the observer stands behind it, when the boat is being driven forward, and right-hand wheel contrariwise. From the point of view of an observer in the boat the water may be regarded as a stationary nut and the direction of rotation in driving ahead is the same as that of a screw thread when turning out of its nut, that is, clockwise for a left-hand screw and contra-clockwise for a right-hand screw

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

NOVEMBER, 1904.

NET CIRCULATION FOR OCTOBER, 1904,—22,437 COPIES.

MACHINERY is published in four editions The practical work of the shop is thoroughly covered in the Shop Edition—$1 00 a year, comprising more than 430 reading pages The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets

THE CONNECTICUT STILL SAFE.

The authorities at the New York Navy Yard have discovered a veritable "mare's nest" in certain reported attempts to scuttle the *Connecticut*, which was recently launched. While any attempt of this character must mark the perpetrator as a dangerous man and a traitor to his country's interest it nevertheless appears that much more importance has been attached to the discoveries than they merit. The attempts to wreck or injure the vessel, if such they were, gave the newspapers material for many columns of sensational matter, but it seems absurd to give the incident the wild-eyed attention that it has received, because the attempts were so weak and puerile as to be scarcely worthy of attention except as indicating the spirit of the perpetrator. In the natural course of events they could have caused little trouble. In one case, it is alleged that four rivets were drilled through longitudinally so as to make holes one inch or less in diameter through each rivet. "A small leak will sink a ship," but we should not anticipate any serious results from such a trifling leak as caused by four one-inch holes in the bottom of a newly-launched vessel, which must necessarily be carefully inspected from stem to stern immediately following the launching to stop small leaks and to discover other defects that always develop. Another alleged attempt was the fixing of a $1\frac{3}{8}$-inch bolt in one of the launching ways so as to stop the vessel or to rip off plates while on its progress to the water. It is absurd to imagine that such a trifling obstruction as a bolt of this diameter would materially impede the progress of a vessel weighing 6,800 gross tons or over 15,000,000 pounds when once it was under way. It is reported that the vessel acquired a speed of fully fifteen knots per hour by the time she reached the water. Allowing that it was only ten knots, a simple calculation, using the well-known formula for kinetic energy $E = \frac{1}{2} Mv^2$, shows that the energy of a body weighing as much as the *Connecticut* when moving at the rate of ten knots an hour or seventeen feet per second, is over 68,000,000 foot-pounds. This enormous force would be sufficient to shear off nearly 1,000 steel bolts $1\frac{3}{4}$ inches in diameter if they were firmly fixed, but a bolt driven into a timber would simply bend over out of the way, and it is quite doubtful if its presence would have ever been known if it had escaped detection before the launching. As a comparison the resistance of the bolt can be considered to be about the same as that of a ten-penny nail sticking up in the way of a modern locomotive when moving at the same speed as the *Connecticut* down the launching ways. It has been suggested that some of our worthy naval officers, who have so vociferously denounced the dastardly attempts, be granted the degree of E. H. (engineer of hysterics).

* * *

SHOP ARRANGEMENT AND COST OF OUTPUT.

We are wont to "pat ourselves on the back" in self-congratulation anent the wonderful improvements in shop construction and tools, and to "point with pride" to groups of new buildings of great extent, filled with the latest improved machinery and laid out in accordance with the ideas of some so-called expert who has figured all costs down to the sixteenth part of a cent. Unfortunately, however, the anticipated improvement is one of name and appearance only in some cases, especially that of a few railway repair shops which have been sadly disappointing in first results. Instead of showing any marked decrease of the cost of repairing a locomotive, the records may show that the cost is fully as much, or even more, under the new shop roof than under the old one that threatened to fall down at any moment. The work does not go off smoothly, and things are generally highly disagreeable for those in charge and responsible for results.

Railway corporations are notoriously reluctant to pay for competent supervision, and that means good foremen. New shops are often laid out on too broad a scale for the present conditions and the attempt is made to handle the work with the same force of foremen as before. The consequence is that the men are left largely to their own devices because it is physically impossible for the foremen to look after them. A man walking at an ordinary gait will cover a distance of about 300 feet per minute; if he has to exercise general supervision in a shop 600 feet long, a round trip means a journey of not less than 1,200 feet and a minimum time requirement of not less than four minutes. But competent shop supervision means a great deal more than merely walking back and forth. Of course the foregoing is an exaggeration because no competent general foreman chases himself about the shop continually; he depends largely upon the reports of his department foremen, but unless a shop is well-organized there will be a serious lack of coördination unless the general foreman gets out and hustles things along a bit. Again a foreman who has been used to a small shop finds himself utterly lost in some of our modern mammoth structures, and for the time being "loses his grip" on things. If railways must build big shops with the various buildings scattered over a quarter-section, they must expect that one of the offsets to the improved mechanical features will be an increased cost of supervision—but it is money well invested.

In this connection we may mention one bad feature of a new railway repair plant (which mechanically is admirable in every way and leaves little to be desired in the present state of the art) and that is the location of the lavatories. There are only two and they are located nearly 1,000 feet apart. The men consequently must lose considerable time going back and forth, and are exposed to the outer atmosphere while doing so. This is a serious drawback in cold weather as often severe sicknesses are traceable to colds contracted by leaving a warm shop in a state of perspiration. Each shop should have its own lavatory, centrally located, if possible.

* * *

A British patent has been granted for a ball-bearing lathe center which has for its object the reduction of the friction that is put upon tail centers by the weight of the work and the pressure of the cutting tool. The center proper is made with the usual V-point for the reception of the work; the body is reduced in diameter so as to slip within a sleeve in which it turns. The sleeve fits the tail spindle taper socket the same as in the ordinary construction. Races are provided in the center and sleeve for ball bearings of the end-thrust type. Frictional resistance to rotation of the tail center is thus reduced to so little that the center turns with the work instead of the work turning upon it, and thus wear is supposed to be practically done away with.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The *Caronia* is a vessel for the Cunard line recently launched at the shipbuilding yard of John Brown & Co., on the Clyde. Her length over all is 678 feet; breadth, 72 feet; depth, 52 feet; gross tonnage, 21,000 tons; draft, 32 feet; displacement at full draft, 29,800 tons; cargo capacity, 12,000 tons; speed, 18 knots. The *Caronia* will have accommodations for 2,650 passengers and will carry a crew of 450.

It is estimated that the New York Rapid Transit Subway will cost complete, $65,000,000; Pennsylvania R. R. tunnel, $50,000,000; New York and New Jersey R. R. tunnel, $15,000,000; Hudson and Manhattan R. R. tunnel, $10,000,000; New York and Queens tunnel, $10,000,000; and New York Central Terminal tunnel, $20,000,000. Total, $170,000,000 for increased rapid transit facilities in Greater New York.

The smallest electric motor in the world has been built by a watchmaker whose work has trained him to handle delicate machinery with the exquisite care required in making a motor that moves with all the regularity of a big machine, and yet is so small that its owner wears it as a scarf-pin. Viewed from a little distance the article has the appearance of a very valuable and rather curiously-designed pin. It is only when standing near to it that its nature can be discovered. The first thing to attract attention is the buzzing of the machine, which, by means of a current obtained from a small battery carried in the vest pocket, is kept in operation at a high rate of speed, with a noise like a bee buzzing. —*Street Railway Review.*

The association of German manufacturers of machine tools, in a report on the condition of the machine-tool industry, complains that sharp competition in foreign markets makes it difficult to obtain orders or remunerative prices, says the consul-general at Frankfort, Germany, under date of September 3, 1904. The importation of American and English machine tools into Germany is notably increasing. During the first half of this year, 1,100 metric tons of foreign machine tools entered Germany, against 450 tons in the same period of the preceding year. The association therefore demands higher tariff rates on imported machine tools, in order to check their importation and thus protect the interests of German manufacturers.

The importance of having light reciprocating parts in engines has been dwelt upon by all authors of works on machine design, but it is quite doubtful if their words have been taken seriously to heart, especially by the designers of locomotives. Many a designer would undoubtedly be greatly surprised if he could be shown the actual results of reducing the weight of reciprocating parts, even so little as 10 per cent. The *Engineer* cites an instance in which the piston of an automobile engine was made of aluminum in order to lighten it as much as possible, and the results are both surprising and gratifying. The speed of the engine was increased 300 revolutions per minute over the maximum that was possible when the heavier cast-iron piston was used.

The use of hot tar or pitch on European highways to prevent dust and to preserve the roadbed from deterioration by water is attracting much attention from those interested in good roads. It appears that ordinary dirt roads, when properly prepared and subjected to the application of hot pitch, can be made practically dustless, and in many respects as good as macadam or asphalt streets, at but a fraction of their cost. The pitch must be applied when the road surface is perfectly dry, and for that reason it must be done during the hot, dry summer months of July, August, and September. The pitch is heated to a temperature of from 140 to 170 degrees F., and thoroughly worked into the road surface, not merely plastered over it. It is poured into the center of the roadway and worked energetically over the surface and into it by means of stiff brooms. This leaves a rough untidy appearance, but a few hours traffic smooths it down, and after that wear is imperceptible for a long time.

We build bridges, skyscrapers, shops, railroads and other engineering structures in very quick time, but for some cause the construction of marine craft appears to be much slower in American shipyards than abroad. This is especially true of the construction of naval vessels; some of our battleships have been five or six years building. During this long period of construction the conditions of warfare, new inventions and improvements in ship construction combine to make a newly-finished battleship of practically obsolete type before she even sees actual service. A writer in *Cassier's Magazine* contends that a battleship could be built in twelve months if its construction was gone at in a business way with complete plans in full detail worked out before construction was started. He says that a large part of the time of building is consumed in making alterations and in finical details of finish which contribute nothing to the efficiency of the vessel as a fighter or as to her seaworthiness.

The committee appointed by the Association of Railway Superintendents of Bridges and Buildings to report at the fourteenth annual convention at Chicago, upon the comparative efficiency of steam hammers and drop hammers for pile drivers, decide in their majority report in favor of the steam hammer. They say that piles can be driven without injury to the pile into almost any kind of earth, and that it is guided home in much better fashion than can be accomplished by the drop-hammer. In Chicago, where perhaps more piles are driven for foundation work than anywhere else in the United States, steam hammers are used almost exclusively. Although the first cost with a steam hammer is much greater than with a drop hammer, its superior efficiency is considered to make the extra cost a good investment. The steam hammer does not require the piles to be banded, and without the bands the heads of the piles are left in better condition than is usually the case with the drop hammer.

The development of the high-powered automobile, capable of running at forty or fifty miles an hour, has brought a train of evil consequences to the users and the public, and it is a matter of grave concern to the automobile industry what the future will bring forth in the matter of repressive legislation if more moderation in speeding on public highways is not displayed by the drivers of these modern Juggernauts. As a matter of fact, however, it is a somewhat difficult matter to accurately judge of the speed of a car and the driver may often believe that he is traveling within the prescribed speed limits when he is considerably exceeding it. A useful device for automobilists who honestly desire to conform to speed regulations is the Warner auto-meter which indicates the rate of progression in direct readings from the slowest up to the highest attainable speeds within the power of the swiftest racers. This device works on the same principle as the cut-meter made by the same concern, and is said to be accurate within limits of one per cent.

A contemporary publishes a picture of a brick chimney 125 feet high which was built from a derrick. The derrick was erected to a somewhat greater height than the chimney, and was built to its full height before the chimney was started. The inside diameter of the chimney is 6½ feet which makes the method of construction from a derrick somewhat puzzling, since the modern method of building chimneys of even smaller bore is to hoist all materials up through the chimney, using the walls of the chimney as a support for the hoisting apparatus and working platform. This method makes falsework unnecessary and considerably reduces the cost of construc-

tion. An analogous method is followed in modern practice in the erection of iron smokestacks. Instead of building a derrick alongside the stack, a short derrick is built around the base to support the stack, as it is being erected. The erection proceeds from the bottom, the succeeding sections being riveted to the bottom of the preceding section, which is held suspended in the air by tackle attached to the top of the derrick.

To even the most casual observer of events, the growing use of cement and concrete in railway and general construction work must be impressive. There are engineers who freely predict that concrete is the coming building material, and that it will supplant wood, brick and stone. When reinforced with iron or steel rods it is used for beams and has the great advantage of high resistance to heat. A sixteen-story office building has been erected in Cincinnati, and this is only one of many complete concrete structures that have been erected in this country and abroad within the past few years. Concrete construction is unique in that its strength increases with age; hence the designer of concrete structures need take no account of the deteriorating effects of age, but on the other hand may rest serene in the knowledge that his allowed factors of safety slowly increase as time passes on. An illustration of this condition occurred in Belgium two or three years ago when a fire occurred in a spinning mill built with concrete floors in 1898. The fire occurred in 1901 and tests made some time after the fire showed that the floors had gained from 130 to 200 pounds per square foot in safe carrying load.

An important change will be made in British patent practice beginning with January, 1905, when no patents will be granted for inventions save only those which stand the test for novelty after a search of the official records for fifty years back. In other words substantially the same practice will be followed as in the granting of German and United States patents. Heretofore in British patent practice, patents have been granted with practically no official search to determine the matter of novelty, so that as a matter of course many worthless patents were granted, but whether in a larger proportion than in American practice where the getting of claims allowed on an exceedingly slender basis has been reduced to a fine art, is doubtful. It is claimed that a large number of so-called "patent agents," "consulting engineers" and other touts have been exploiting the British patent office for their own ends. They have played on human vanity and credulity in getting worthless patents for parties who imagined that their social status was immensely improved by becoming patentees, or whose cupidity was played on by rosy prospects of immense returns for some foolish trifling thing of absolutely no novelty or value.

A consular report from Auckland states that an interesting change has recently been made in the signaling system in New Zealand's railway which it is thought will make collisions absolutely impossible. For a long time, up to a recent date, what is known as the "block" system has been generally used, but the "tablet" system has now been introduced. The essential point in the new system is that no engine driver is allowed to leave a station without a tablet in his possession, and the element of safety rests on the fact that the machines are so made that it is impossible for two of the tablets to be out at the same time. If a driver leaves Auckland for Newmarket with a tablet, that tablet has to be deposited in the machine at Newmarket before another tablet is issued allowing a return train to leave that station for Auckland, and the electrical connection between the two stations makes it impossible to extract a tablet from the Auckland machine until the tablet has been put into the machine at Newmarket. It is claimed by railroad experts that under the new system two trains cannot be on the same section at once, so that the danger of collisions is entirely done away with.

LONGEST PIPE LINE.

The use of the pipe line for the transmission of petroleum over long distances was undoubtedly one of the greatest advances in the handling of a certain class of freight since the invention of the locomotive; the cost of pumping oil is much less than shipping in barrels or tank cars and the danger of fire is minimized. The pumping stations at intervals are the only visible evidences of such a route, and the pipe line itself follows a "bee line" over hill and down dale with absolutely no deviation from a straight line to ease the grades. It lasts indefinitely because of the preservative effect of the oil, and calls for practically no attention save the periodical patrol of the pipe-line walker who covers as much of its length daily as he is able to walk at a stiff gait. Occasionally a leak will spring forth, but it is usually known in the pump stations before it is discovered by the patrol, if of serious proportions. All the pump stations are connected by telegraph or telephone lines, and the amount pumped from each station is transmitted to the next station by wire. This report must tally with the number of barrels received; if it does not it is known that a leak has developed or that an error has been made in the report. The longest pipe line in the United States will be that from Red Fork, Indian Territory, to Bayonne, N. J., a distance of 1,800 miles. The pipe line itself contains thousands of barrels; it requires something like 20,000 barrels to fill the line from Red Fork to Kansas City alone.

TRIPLE VAPOR ENGINE.

The binary-vapor engine using sulphurous acid gas and steam, which was designed and built for Prof. Josse, of the Royal Technical High School, Charlottenburg, Germany, has attracted much attention—more perhaps on account of its theoretical interest than its practical possibilities. Yet when it is considered that this system increases the power production fifty per cent. for the same steam consumption, it must be admitted that there is a powerful advantage in favor of the use of two or more substances having different vaporization temperatures. Another German, Mr. K. Schreber, has shown that with a triple-vapor engine it is possible theoretically to secure a heat efficiency of nearly 38 per cent. He proposes the use of ethylamin, water and aniline. Ethylamin can be advantageously worked between the temperatures of 85 and 180 degrees F.; water in the form of steam between 180 and 360 degrees F.; and aniline between 360 and 600 degrees F. In Mr. Schreber's imaginary engine aniline is heated in a boiler and after passing through the engine, it is cooled in a condenser, the liberated heat being utilized to evaporate water which has already been heated by passing it through an economizer. In the second stage the steam passes through a second engine into a condenser where its heat evaporates ethylamin, also previously heated by the waste gases of the boiler passing through an economizer. The ethylamin works a third engine and is condensed for re-use. If the limits are placed at 70 and 600 degrees F. instead of 85 and 600 degrees, the author of the paper figures that the heat efficiency would be 44.5 per cent.

ALLEGED DISCOVERY OF THE PROCESS FOR MAKING HARD RUBBER.

There was once a machinist named George, who worked at the bench and was always more interested in hearing the quitting time whistle blow than in any other event of the day. One day the first yell of the whistle found him with his hammer in the air, and being alarmed lest it should make even part of a stroke beyond working hours, he permitted the hammer to fall and it broke a bottle containing a certain chemical which happened to be on his bench and the fluid ran over a sheet of rubber that also was on the bench. To wipe up the mass after the whistle had blown was not the way George did business, so he went home. In the morning when he examined the rubber that had soaked all night in the fluid, he found that it was as hard as a piece of board. Here now came in the worldly wisdom of this machinist. Instead of cleaning up his vise bench, and throwing the spoilt rubber and broken chemical bottle into the rubbish box without thinking anything more about the mishap, George reflected that the change in the consistency of the rubber was due to the chemical that had been anointing it all night. Then the question occurred, Would hard rubber have any value as an industrial product? The secret of how to make hard rubber was carefully guarded, a com-

pany was formed to put articles made from it upon the market and the discoverer is now a multi-millionaire.—*Locomotive Engineering.*

RECUPERATIVE POWER OF PEAT.

Page's Magazine, September, 1904.

A good deal has been heard recently about the utilization of peat on a large scale, and it may be interesting to point out that peat differs from coal in that after removal a fresh lot *grows up* again. The rate varies in different parts of the world, but the following are some well authenticated cases:

Lake of Constance—A layer of 3 feet to 4 feet thick in 24 years.

Near Hanover—A layer of 4 feet to 9 feet thick in 30 years.

Valley of Somme—A layer 3 feet thick in 30 to 40 years.

Of course, a great deal depends on the peat-forming value of the mosses, and on various geological and geographical features of the country. Some mosses may only give a foot thickness of peat in 30 years, but taking peat bogs the world over 10 feet in 100 years seems to be a fair average.

Taking these figures and assuming absolutely safe data for working out the horse power, we arrive at rather interesting figures.

Assuming that one cubic foot of cut peat will give 10 pounds of solid fuel, and that 5 pounds of peat fuel are equivalent to one brake horse-power hour, then it can be shown that 640 acres or one square mile of peat bog 10 feet thick, will give:

$$\frac{640 \times 43560 \times 10 \times 10 \text{ lb.}}{5 \text{ lb.}} = 550{,}000{,}000 \text{ B. H. P. hours.}$$

If we assume that the square mile of peat bog grows at the rate of 10 feet in 100 years, then we may say that such a peat bog is good for—

$$\frac{550{,}000{,}000}{365 \times 24 \times 100} = 630 \text{ B. H. P.}$$

for all time. As a matter of fact the working day may very well be taken at 10 hours, so that 1,500 B. H. P. may be calculated as the output of a square mile of peat bog, so worked that it is never permanently diminished.

RELATIVE COST OF CUTTING BY EMERY WHEELS AND BY FILING.

Extract from Paper presented by Mr. T. Dunkin Paret, at the May 12, 1904, Meeting of the Franklin Institute.

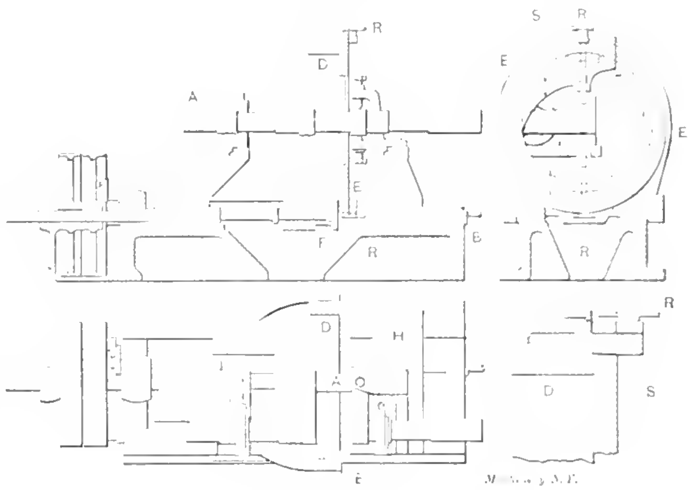
An attempt has been made to arrive at the cost of grinding both on cast and wrought iron, and also at the cost of filing, but it must be remembered that the conclusions which are drawn from very unequal series are not altogether sound. In arriving at these costs, a wheel 10 x 1 is assumed to weigh 7¾ pounds and to cost $1.65—that is, 75 per cent. discount on a list price of $6.60. Labor is calculated at the rate of $1.75 for a day of ten hours. No allowance is made for power. Under these conditions, and counting only the cost of wheel material and the actual time of grinding, at a pressure of 112 pounds, it costs 5 26-100 cents to grind 1 pound of cast iron and 27 53-100 cents for the same quantity of wrought. This cost, so far as it refers to cast iron, is derived from the 214 minutes test of thirty-six wheels. It is interesting to note that the few trials of specially fast cutters show a diminished cost. This diminished cost (on cast iron) is almost the same at 80 and 110 pounds. At 110 pounds the cost of material is greater than at 80 pounds, while the cost of labor is less. At 80 pounds the total cost is 3 40-100 cents per pound; at 110 it is 3 52-100.

A few tests were made with the file on bars furnished for the grinding test, three different machinists being timed. These gave a cost per pound of 29 90-100 cents for cast iron and 74 75-100 cents for wrought. The minute removal by the file for cast iron was 15-100 of 1 ounce; for wrought iron 6-100.

LATHE FOR TURNING CRANKS.

Zeitschrift fur Werkzeugmaschinen und Werkzeuge, April 5, 1904, p. 271.

A lathe attachment made by Emil Capitaine & Co., Frankfort-on-Main for turning cranks and other similar articles is shown herewith. The tools are attached to a rotating ring, that revolves about the center of the part to be turned. In the illustration the device is shown to be formed of two independent parts, that may be separated from each other for the introduction of the work. These two parts *E* and *E'*, when fastened together serve as a support for the rotating ring *D*. The transverse feed is obtained by means of a star wheel *R*.


Crankshaft Lathe.

working through a light spindle *S*. Each section of the ring carries a cutter, so that the work can be executed with two tools at once, thus giving the advantage of having cuts taken on opposite sides which tends to avoid chattering. The crank *A*, to be turned, is fastened to the bolsters *H H*, which are given a longitudinal feed motion by a mechanism not shown.

G. L. F.

KRYPTOL, A NEW SUBSTANCE FOR ELECTRIC HEATING.

Abstract of Consular Report No. 2084 by Frank H. Mason, Berlin.

Among the notable recent German inventions in the field of applied science is an electric resistance material for heating purposes, to which has been given the name "kryptol." The exact method of its preparation and the proportions of its ingredients employed are not disclosed by the specifications of its patent, but it is a mixture of graphite, carborundum, and clay so combined as to form a loose granular mass or powder of four grades or degrees of coarseness, which are severally best adapted to different heating operations.

Electric heat may be developed by two general methods: The electric circuit may be broken, so that a voltaic arc is formed, and the charge in the furnace is thus heated directly, or the current may be transmitted through a conductor that offers enough resistance to generate heat, which is imparted to other substances by contact. This is the indirect electrical heating system, of which kryptol offers the latest and most interesting example.

The two main difficulties inherent in voltaic-arc furnaces are (1) Only very high temperatures are developed, which are difficult to modify or control, and (2) the arc consists largely of incandescent particles of (usually carbon) electrodes, which render the flame so impure as to preclude its use for many important purposes. Both of these defects are remedied by kryptol, which develops heat of any desired intensity from a gentle warmth up to 5,400 degrees F., and is clean and free from dust and other impurities. Moreover, it avoids the use of platinum, nickel, and other metallic wires and foils that have been hitherto used in resistance furnaces, thereby securing important economy and avoiding the danger of short circuiting and other accidents, which is always more or less present when metallic spirals in connection with crucibles are used.

The property of kryptol, upon which its efficiency depends, is the fact that it offers to an electric current the requisite degree of resistance to generate a high degree of heat without destruction to its own substance. The apparatus consists simply of a chamotte or earthenware plate inclosed at its edges in a wooden frame and bounded at two opposite sides

by carbon electrodes which rest upon the plate and are connected by insulated wire conductors with a current supply, forming an electric current when the break between the electrodes is closed. Upon the chamotte plate, which is usually about two feet square, but may be of any convenient size, is loosely strewn the granulated kryptol to a depth of about an inch. When the kryptol is laid continuously across the plate it forms the electrical connection between the two electrodes and closes the circuit. When, however, the kryptol is brushed or scraped aside so that an open, uncovered space is formed through the layer across the plate, the circuit is broken and the apparatus remains, so to speak, dead. If now the kryptol is brushed into the open space, so as to form a connection between the two masses lying against the electrodes on either side, the circuit is at once restored, and the kryptol forming this thin connecting layer begins to sparkle and glow, becoming in a few moments incandescent and generating a heat that will raise cold water to boiling in three or four minutes.

A peculiarity is that the incandescent action takes place only at the places where the layer of kryptol on the plate is thinnest, and it is therefore easily possible to create heat just in the place where it is wanted and not elsewhere, for in this case the thick bed of granular material on other portions of the plate remains cool and impassive and may be touched or stirred by the naked hand with entire impunity. The finer the grains of kryptol the less active is the incandescence, and it is for this reason that the four different grades or numbers of the material are made, to be used as may be required in generating different temperatures.

This extreme tractability, by which the temperature can be absolutely regulated by increasing or diminishing the strength of the current or by altering the thickness of the kryptol layer, one or both, renders it applicable to a large variety of practical uses; it lends itself with great convenience to all the finer smelting operations in scientific and industrial metallurgy. These operations may be carried on by means of a small crucible furnace, which consists of an iron shell with an enamel lining filled with coarse-grained kryptol, in the center of which is hung a movable graphite crucible, in which any temperature up to 3,600 degrees F. may be generated. With a current of 15 amperes, nickel, the smelting point of which is about 2,900 degrees F., may be fused in about six minutes.

Some of the steel and cutlery manufacturers in Westphalia are experimenting with kryptol with a view to its employment for tempering, annealing, and case-hardening steel and iron bars, knives, scissors, and other implements. Such processes would become thereby automatic and independent of the skill of the workman. As the ingredients of kryptol will withstand any temperature up to 5,400 degrees F., its use for heating up to that limit is restricted only by the nature of the material of which the furnace and crucible are composed. Being itself a poor conductor of heat, it retains its warmth for a long time.

For chemical laboratories the new material has already been adopted by the University of Berlin, the Technical College at Aix la Chapelle, the Imperial health office at Berlin, and other State institutions. When used in ovens and heating devices of various patterns it enables the chemist to heat substances to any desired temperature and to maintain an unvarying degree of heat for an indefinite period. In elementary organic analysis it is frequently necessary to heat parts of the substance under examination to different temperatures and to leave another portion not heated at all. For this purpose a simple but effective apparatus has been devised. It consists of an iron frame on which is laid a fire-brick trough or gutter, glazed inside and filled with kryptol. In this is laid the combustion pipe, which may be a glass tube, containing the material to be treated. The current being sent through the whole, even mass of kryptol, heats the tube uniformly throughout its length; but when it is desired to heat one portion to a high temperature, it is only necessary to scrape the kryptol aside and reduce the thickness of the layer under that part of the tube, when it at once begins to glow with accelerated heat, while the temperature of the other parts remains unchanged. If it is desired to withdraw or exclude the heat entirely from the central part of the tube, two copper forks, which slide along a brass conductor, are introduced into the kryptol, which take up the current and pass it by the conductor over the intervening space, leaving the kryptol and that section of the tube cold and excluded from the heating operation.

A NEW PROCESS FOR THE PROTECTION OF IRON AND STEEL FROM CORROSION.

Abstract of Article by Sherard Cowper-Cowles in the Electro-Chemist and Metallurgist, June, 1904.

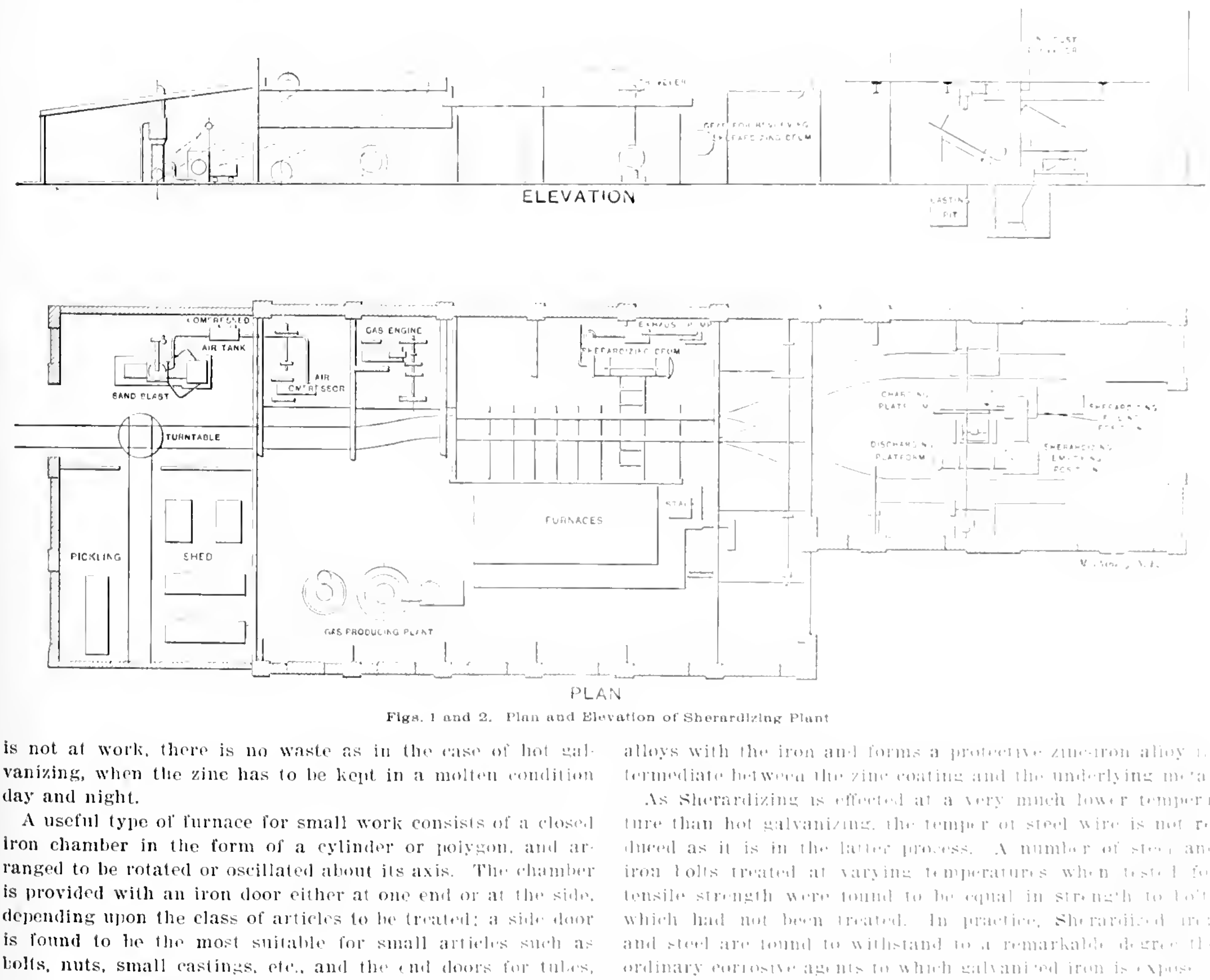
Zinc has proved the most effective coating for iron and steel, and hot galvanizing, with all its attendant disadvantages, is the process most extensively used for applying the zinc coating. Electro-zincing or cold galvanizing is used for special classes of work, and is extensively employed by the Admiralty for giving boiler tubes a thin flashing of zinc for the purpose of detecting flaws and protecting the tubes from corrosion during the time of assembling and erection. Works have just been completed for a new process to which the name of "Sherardizing" has been given. One point of particular interest about the new process is that iron and steel can be coated with an even deposit of zinc at a temperature of several huudreds of degrees below the melting-point of zinc.

The first step in the process is to free the iron from scale and oxide by any of the well-known methods, such as dipping in an acid solution or sand-blasting. The articles to be rendered rustless are then placed in a closed iron receptacle, charged with zinc dust, which is heated to a temperature of from 500 degrees to 600 degrees F. for a few hours and allowed to cool; the drum is then opened and the iron articles removed, when they are found to be coated with a fine homogeneous covering of zinc, the thickness depending on the temperature and the length of time. It will be observed that the temperature required to bring about this result is about 200 degrees below the melting-point of zinc. The low temperature required makes the process cheap as compared to the process of dipping in molten zinc, and has the additional advantage that it does not deteriorate iron or steel of small section to the same extent as hot galvanizing. The whole of the zinc dust is consumed; there is no waste of zinc as in the hot galvanizing process. This new process of galvanizing is not limited to the coating of iron with zinc, it has been successfully applied to coating iron with copper aluminum and antimony. It has also been applied to various other metals, for instance, aluminum and copper with zinc. Copper and its alloys subjected to this process are casehardened on the surface, and can be rendered so hard as to turn the edge of a steel tool.

The zinc powder used in the process is the zinc dust of commerce, and must not be confused with zinc oxide; it is obtained during the process of distilling zinc from its ores. Zinc dust at the present time is used for a variety of purposes, and can be obtained in any desired quantity. The average price of zinc dust for the year 1903 was $95 per ton, (Great Britain) which is slightly below the average price of virgin spelter. The analysis of two samples of zinc dust such as are employed for Sherardizing gave respectively 85 and 85.06 per cent. and 81.86 per cent. metallic zinc. Both samples, when examined under the microscope, seemed to contain small bright metallic beads, unevenly distributed through the dust, and it is probable that this may account for the different percentage given by analysis. One of the peculiar properties of zinc dust is that it cannot be smelted or reduced to the metallic form under ordinary conditions, even when heated to a very high temperature under considerable pressure. This property is very advantageous for the new process of dry galvanizing, as it does away with the risk there might otherwise be of melting the finely-divided zinc by overheating the furnace. The receptacle in which the zinc dust is placed and heated is preferably air-tight and the air exhausted so as to prevent the formation of too much zinc oxide; or, if this is not feasible, it is advisable to add about three per cent. of carbon in a very fine state of division. If the percentage of oxide is allowed to increase beyond certain limits it is found that the deposits become dull in appearance instead of having

a bright metallic luster, although good deposits of zinc can be obtained from zinc dust varying considerably in composition. To prevent the iron receptacle in which the process of Sherardizing is carried on from becoming coated with zinc, it is found advantageous to coat the inside of the drum with plumbago or black lead. Articles coated with grease receive as good, if not a better coating of zinc than those which are free from grease. This fact is of considerable importance, as it enables machined work, such as bolts, nuts, screws, etc., to be thrown direct after machining into the Sherardizing drum without any preparation or cleaning. The articles when they have been heated in the zinc dust for the period necessary to obtain the thickness of zinc required, can be removed, while the zinc dust is still hot; although the better practice is to allow the zinc dust to cool to a temperature at which the articles can be readily handled, as the deposit of zinc is whiter and less oxide of zinc is formed. The new process of dry galvanizing offers many facilities and great economy to those manufacturers who have not sufficient work to keep a large bath of molten zinc continuously at work. Articles can be Sherardized at a few hour's notice, starting all cold, as the drums can readily be heated by gas or coke furnaces, the whole operation occupying only a few hours. When the plant to the back of the furnace. The discharging or charging of the drum is effected by running the truck on which the drum is placed onto a table, the latter being tilted by gearing so that the drum can be discharged or charged with zinc dust from a chute above. After being charged with zinc dust and the materials to be galvanized the drum is brought to a horizontal position, the cover closed and the air exhausted, when it is ready to be charged into the furnace.

The comparison of the surfaces obtained by hot and cold galvanizing and Sherardizing is different in each case, but they can readily be distinguished by anybody conversant with the three processes. In the case of hot galvanizing, the surface is spangled, or has the appearance of cast-metal. In the case of cold galvanizing, the surface is free from spangles and has a matte or frosted surface, uniform if the work has been well executed. Sherardizing is again distinctive from the two former processes; the general appearance resembles more that of cold galvanizing than hot galvanizing, but is more lustrous and metallic, and is uniformly distributed over the whole surface, which is not the case with the hot and cold galvanizing processes. The Sherardizing process, although similar to cold galvanizing in some respects, is also similar to hot galvanizing in other respects, inasmuch as the zinc



Figs. 1 and 2. Plan and Elevation of Sherardizing Plant

is not at work, there is no waste as in the case of hot galvanizing, when the zinc has to be kept in a molten condition day and night.

A useful type of furnace for small work consists of a closed iron chamber in the form of a cylinder or polygon, and arranged to be rotated or oscillated about its axis. The chamber is provided with an iron door either at one end or at the side, depending upon the class of articles to be treated; a side door is found to be the most suitable for small articles such as bolts, nuts, small castings, etc., and the end doors for tubes, oblong or cylindrical articles. In the latter case the cylinder is oscillated and rotated on its axis; in the former case it is rotated and provided with baffle plates to insure the articles under treatment being turned over and thus becoming uniformly coated by bringing all parts into intimate contact with the zinc dust.

Figs. 1 and 2 show the general arrangement of a Sherardizing plant which has recently been completed, comprising four furnaces capable of taking drums 2 feet by 8 feet. These drums will hold about two tons of material, the weight depending on how closely the articles pack. The furnaces are heated by Dowson producer gas, which is led by iron pipes alloys with the iron and forms a protective zinc-iron alloy intermediate between the zinc coating and the underlying metal.

As Sherardizing is effected at a very much lower temperature than hot galvanizing, the temper of steel wire is not reduced as it is in the latter process. A number of steel and iron bolts treated at varying temperatures when tested for tensile strength were found to be equal in strength to bolts which had not been treated. In practice, Sherardized iron and steel are found to withstand to a remarkable degree the ordinary corrosive agents to which galvanized iron is exposed; even after the apparent removal of all the zinc by filing or abrasion the iron is still non-corrosive. This valuable property is doubtless due to the protective action of the zinc-iron alloy formed on the boundary line between the iron and zinc. The dry process of galvanizing is cheaper than hot galvanizing for the following reasons:

1. Less zinc is required to give the same protective coating, as the zinc is evenly distributed. 2. The temperature required is low. 3. The labor is less, as the articles do not require to be cleaned as carefully as in hot galvanizing. 4. No flux is required, no dross or skimmings are formed. 5. There is no danger of explosion or breaking of castings and distort

ing of thin iron work. 6. Sherardizing machine work does not require refitting, as the coating is evenly distributed. 7. There is no reduction in tensile strength as in the case of hot galvanizing. 8. The coating is more uniform and even than that obtained by hot or cold galvanizing. 9. The work can be placed direct in the Sherardizing drum from the pickling vat without drying. 10. The process can be worked intermittently without waste. 11. Iron can be coated with zinc to any desired thickness.

TRADES AND FACES.

English Mechanic and World of Science, August 19, 1904, p. 26.

It is an undisputed fact that a man's trade or profession affects, to a more or less noticeable extent, not only his disposition, but even his physiognomy. That certain faces appertain to certain callings is a matter of everyday observation. The expression of the "horsey" man—be he trainer, jockey, or groom—is quite unmistakable and peculiar. The professional cast of features of the doctor or the lawyer is equally well known, and yet more strikingly distinctive is the face of the actor. Butchers and shoemakers, tailors, publicans, and men-servants all have facial peculiarities which they hold in common with all other members of their trade, and to a keen observer of expression all workers of whatever station bear upon their features the impress of their labor. One specially instructive instance, among many others, has been related by a well-known medical man. In his work as surgeon in the hospital of a shipbuilding town, he was struck with the lowering brows and forbidding expressions of the riveters and boiler-smiths with whom he came in contact. Only by experience did he come to understand that the apparent watchful hostility which each seemed to exhibit was in reality a trick of the countenance merely, and not at all indicative of the actual feelings. And pondering over this he arrived finally at the conclusion that the scowling look, which he maintains is common to all kinds of smiths, is due to the constant automatic contraction of the brow to protect the eyes from the flying sparks, as the heavy sledge descends on the glowing metal. A blacksmith is, as a rule, credited with being a serious and downright man, who "looks the whole world in the face" and stands no nonsense. It has been suggested that the mere act of striking heavy blows, accompanied as it always is with a flush and a frown, has about it so much suggestion of wrath and determination as in time to affect the character to a certain extent. In the case of the shipbuilders also their work is so noisy as to render them all slightly deaf, which infirmity always gives a closely watchful expression to the features. Another curious, and some may think far-fetched, explanation of a "trade expression" has been given in the case of the tailor. Let anyone watch the face of a person engaged in cutting a thick piece of material with a pair of scissors, and it will be seen that the lower part of the face works in involuntary unison with the blades. May not (so it is argued) the constant working of a tailor's jaws concomitantly with his shears help largely toward bringing about that cast of countenance which distinguishes him?

The well-known and recognized type of face belonging to the horsey man has its peculiarity chiefly in the set of the mouth and chin. This is explained from the fact that the muscles which close the jaws and compress the lips are always called into play when we are asserting our will over that of a horse. The incessant manifestations of his own power and will over that of an animal tends to give that firmness of jaw and thinness of lip which a horseman wears. It is somewhat different when the command is exercised over men instead of animals. The firm mouth is still seen in the drill-sergeant; but the commanding eye—which is absent in the groom—is also added, because in dealing with men the higher method of expressing authority is made use of. Generally speaking, it is strenuous contest with ever-recurring minor difficulties which produces thin and compressed lips. Many housewives who suffer the little worries of life to prey upon them, or whose existences are a perpetual struggle to make both ends meet, exhibit this peculiarity, even to extremes. Compressed lips are generally rather a sign of weakness than strength. A strong will is above the perpetual petty strife they indicate. The commanding officer, sure of his men's obedience, lacks the look of tension which his sergeants wear, and that absolute monarch the sea-captain, though his face carries authority and power, has the easily-set mouth of confident assurance. It has been remarked that there is a certain marked resemblance between the types of face, especially the calm lips, belonging to the naval officer and the engine-driver, brought about by the fact that both are absolute masters of the powers they control.

* * *

OBITUARY.

J. Ramp.

Mr. J. B. Ramp, one of the men who witnessed the most important years in the mechanical development of this country, died on September 11th, at Burlington, Iowa. During his long career he was continuously engaged in the foundry business. He was born in 1830, in New York City, and began to learn the foundry trade in his thirteenth year, taking the position of foreman when he was 21 in the shop where he served his apprenticeship, at Trenton, N. J.

Mr. Ramp served four years as a volunteer in the Federal Army and returned at the close of the war to accept a position with the Turner & Vaughn Iron Works of Cuyahoga Falls, Ohio, where he was superintendent of the foundry until the time of the erection of the large Mississippi River locks at Keokuk, Iowa. The foundry business at this point needed a man who could successfully produce the large and complicated casting necessary for the construction of these locks and it was this interest that induced him to come West.

In 1882 Mr. Ramp accepted a situation with the Murray Iron Works Co., of Burlington, Iowa., where he spent the rest of his career as superintendent of the foundry department. During his twenty-two years' service there the foundry has grown to three times its original size and capacity, and is to-day said to be the best equipped foundry in the West. During Mr. Ramp's direction there has never been a strike, and not until late years was there any regular organized union. He endeavored to bring the workmen to see that their foreman was their best friend, while able management and energetic, resourceful efforts on his part made his work profitable to the company. Molders who entered the shop for the first time were usually impressed with its orderly appearance and systematic arrangement, and many who served their apprenticeship under Mr. Ramp command first-class positions to-day. Among these are Mr. Ramp's two oldest sons, Herbert M. Ramp, superintendent of the General Electric Company's foundry and iron department, Schenectady, N. Y., and Paul R. Ramp, superintendent of the foundry department of the Wheeler Condenser and Engineering Works, Carteret, N. J.

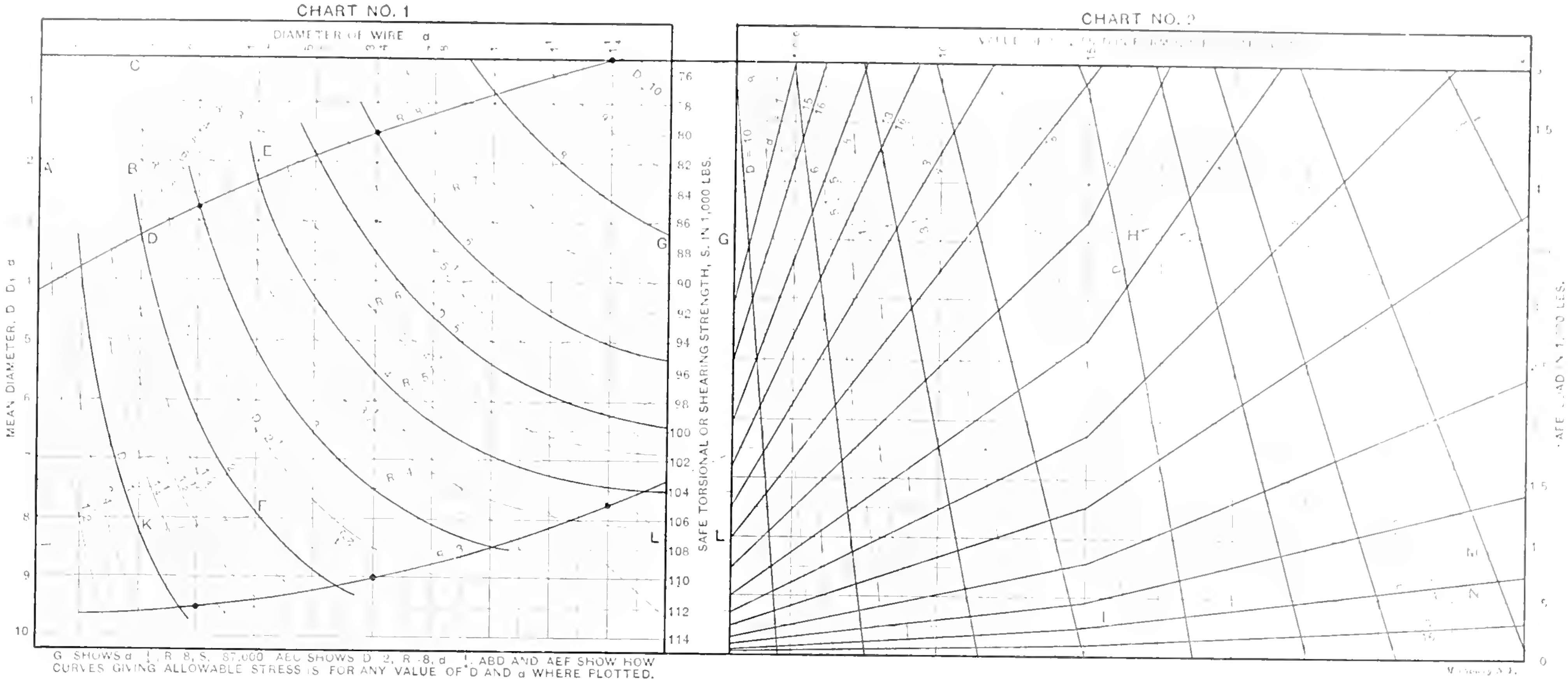
Seven or eight years ago Mr. Ramp devised a molding machine to do the heavy ramming involved in making heavy castings. The machine has since proved its efficiency and durability and is in operation to-day. Cars are arranged to carry the heavy flasks under an air cylinder press, where the mold is rammed evenly in an instant and then drawn away. The past year the machine was enlarged and improved so that four operators can be at work at the same machine and two whole molds can be made at the same time.

* * *

To get a nicely mottled effect on casehardened work a toolmaker recommends that instead of dipping it all under at once in the hardening bath, the dipping be done jerkily; the result is a series of mottled bars across the work, each of which denotes its position at the surface of the bath as it was momentarily arrested in the plunge.

* * *

The bridge over the Zambesi River at Victoria Falls on the Cape-to-Cairo railroad in Africa is 420 feet above the low water level.



These two Diagrams show the Method of Constructing Chart No. 3. They are Drawn to the same Scale as the latter.

CHARTS IN DESIGNING.—3.

HELICAL SPRINGS.

JOHN S. MYERS.

Desired: A chart for helical springs of round steel giving the safe load and deflection of same. This series of charts is intended to illustrate the development of curved line charts from straight line ones.

The formula for safe load is $P = \dfrac{Sd^3}{2.55\,D}$, where P = safe working load in lbs., S = safe torsional or shearing strength of bars, and D = mean diameter of coil = outside diameter D_1 —diameter of bar d.

From "Machine Design," by Prof. C. H. Benjamin, the safe value of S as deduced by experiment,* varies with the ratio of mean diameter of coil to diameter of bar, and also with the size of bar used. Safe values are given in the following table, where R = the above ratio.

For bars below ⅜-inch diameter,

$R = 3.\quad S = 112{,}000.$
$R = 8.\quad S = 85{,}000.$

For bars 7-16 inch to ¾ inch diameter,

$R = 3.\quad S = 110{,}000.$
$R = 8.\quad S = 80{,}000.$

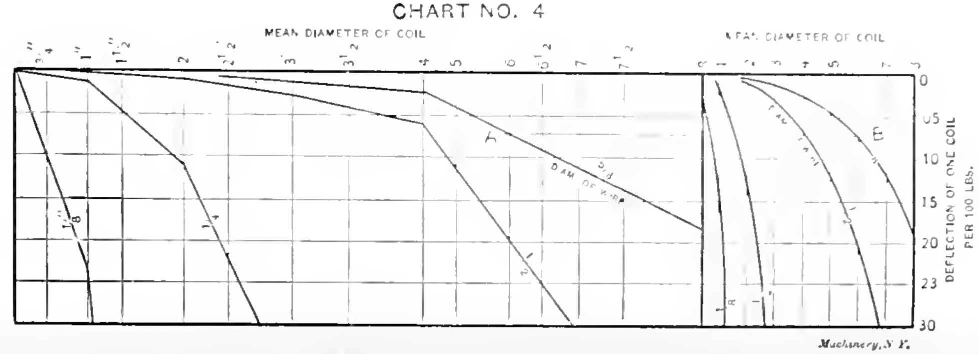
For bars 13-16-inch to 1¼-inch diameter,

$R = 3.\quad S = 105{,}000.$
$R = 8.\quad S = 75{,}000.$

In chart No. 1 the diameter of wire was first laid out on a uniform scale at the top of the chart and values of S ranging from 75,000 to 114,000 on the side of the chart. The stress as given in the table above was then spotted off for $R = 3$ and $R = 8$, on the line corresponding to diameter of bar, and a curve $R = 8$ and $R = 3$ drawn through the points.

The intervening space was then divided into 5 equal parts

CHART NO. 4



Showing the Method of Constructing Chart No 5.

* These experiments were conducted by Mr. Roy A. French and were part of his thesis for a master's degree.

CHART NO. 3

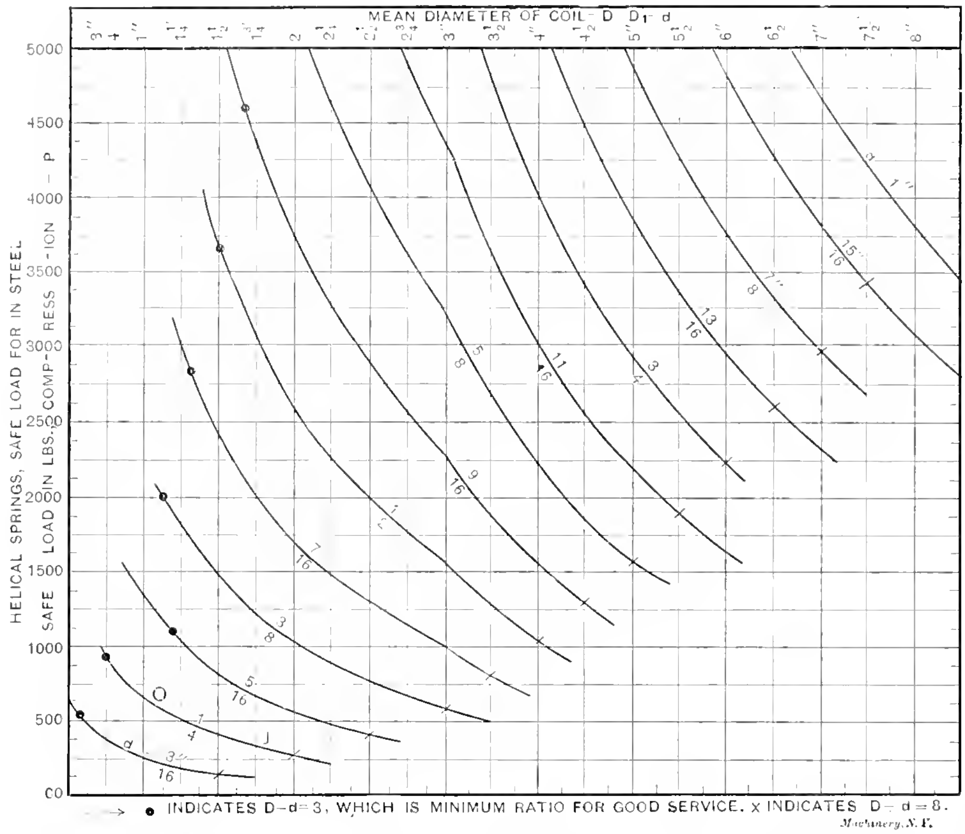


Diagram showing Safe Load for Coil Springs of different Diameters, from Wire of different Diameters.

Notation for Chart No. 3.

D = mean diameter of coil = $D_1 - d$.

d = diameter of wire.

S = safe torsional or shearing strength.

P = safe load.

$$P = \frac{S\,d^3}{2.55\,D}$$

For extension springs $P = 2/3$ of above value. Where springs are subjected to shock use about 2/3 P. The foregoing is for round bars. For square bars safe load = 1.2 × P for round bars.

Let $R = D \div d$; then,

For Bars Below	$R =$	$S =$
3/8" diam.	3	112,000
	8	85,000
3/4" diam.	3	110,000
	8	80,000
1 1/4" diam.	3	105,000
	8	75,000

(From Summary of Tests by Prof. C. H. Benjamin, at Case School of Applied Science. Relations of D, d, R and S are shown in Chart No. 1 on the previous page.)

ERRATA: Chart No. 1, for "G shows, etc." read "C D G shows." Chart No. 3, for "Indicates D−d=3," read "Indicates D÷d=3."

and the curves R = 4, 5, 6 and 7 drawn through. These lines now give values of S for any value of d and R. Thus $C\,D\,G$ shows diameter of wire d = 1/4-inch; ratio R = 8; safe stress S = 87,000. Next the side scale was numbered to represent mean diameter $D = D_1 - d$, and lines drawn to perform an operation of division $\frac{D}{d} = R$, for values of R = 3, 4, 5, 6, 7 and 8. Thus $A\,B\,C$ shows D = 2 inches; R = 8; d = 1/4-inch. The curves representing D were then drawn by projecting, thus $A\,B\,D$ and $A\,E\,F$ being two points on the curve D = 2 inches. These curves now give the value of S for any value of d and D.

Chart No. 2 was then constructed, the side representing values of S being adjacent to chart No. 1, S being taken as the first factor. The second factor is $\frac{1}{2.55\,D}$, thus the top of chart represents $\frac{S}{2.55\,D}$. The other set of sloping lines marked d represent the value of d^3 and perform the operation of multiplication, thus giving value of P in formula, $P = \frac{S\,d^3}{2.55\,D}$.

Chart No. 3 was then constructed by projecting points from No. 2, thus $C\,D\,G\,G\,H\,I\,J$ and $C\,K\,L\,L\,M\,N\,O$ show the projection for points on the curve which represents d = 1/4-inch. Chart No. 3 is thus complete in itself, Nos. 1 and 2 being used only in developing the curves.

Desired: A chart for helical springs of round steel, giving the deflection.

Begtrup's formula is $F = 8\frac{P(D_1 - d)^3}{E\,d^4}$. Taking E at 14,500,000, as stated by Prof. Benjamin, the deflection for one coil per 100 pounds $= \frac{1}{18125}\,\frac{D^3}{d^4}$. Chart No. 4 shows to a small scale the construction and development of curves in Chart No. 5. The top of chart No. 4 represents values of D^3, the sloping lines values of $\frac{1}{18125\,d^4}$ and perform the operation of division, thus the side gives the deflection $= \frac{1}{18125}\,\frac{D^3}{d^4}$. Points were projected into a smaller and more convenient chart on the right giving the curved lines shown. Thus A projected to B gives a point on line D = 6 inches, which curve representing 5/8-inch diameter wire passes through. Chart No. 5 gives these lines to a convenient scale for interpolation.

While the formulas read mean diameter, if it were thought advisable to have the charts read outside diameter this could be readily accomplished by shifting each curve when tracing.

CHART NO. 5

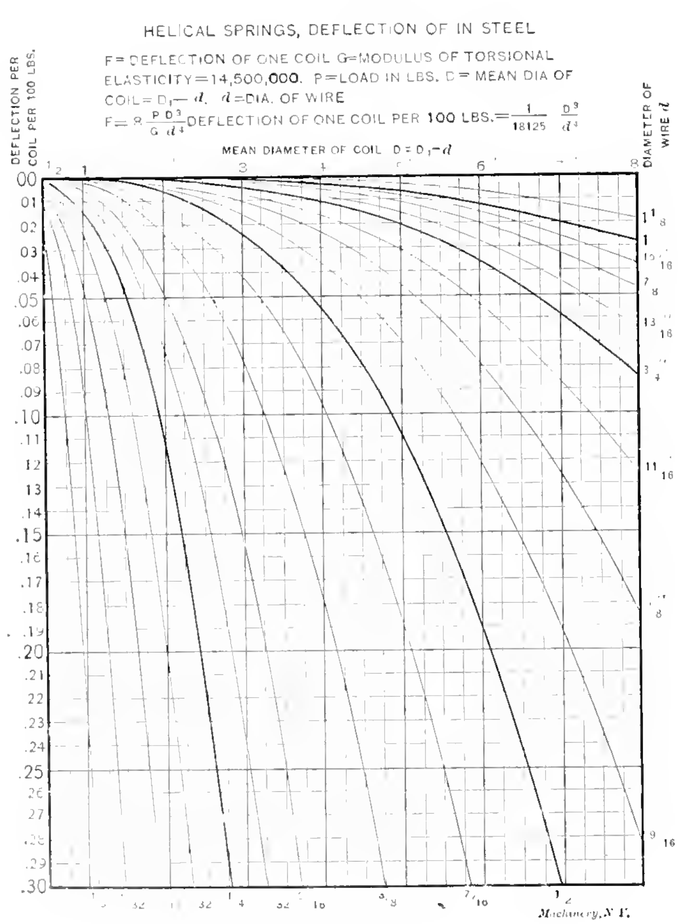


Diagram showing Deflection of Coil Springs.

THE "DE FRIES" PRECISION LATHE.

DR. ALFRED GRADENWITZ.

Dr. Alfred Gradenwitz.

In a precision lathe recently brought out by the firm of De Fries & Co., Düsseldorf, Germany, there is applied a novel construction in place of the usual lead screw by which it is claimed that extreme accuracy is obtained so that screws of any desired length may be cut of very accurate pitch.

Heretofore thread cutting has simply consisted in copying an existing lead screw, the latter being in turn copied from a master screw. There has been a serious drawback in this method, however, for producing accurate threads, because it has been extremely difficult to procure a master screw of uniform pitch, and any error in the pitch would be reproduced in the second screw. Now the De Fries lathe is quite independent of any existing screw, since a *lead nut* cut in halves longitudinally, thus making a long half nut, which is used in place of a lead screw. This nut runs along the bed of the lathe, and a bronze screw forming part of the mechanism of the carriage meshes with the threads of the nut. The screw is driven by change gears and a splined feed shaft located in the usual position, below the lead nut, as shown in the illustration. The thread grooves of the nut are cut singly by means of a special patented apparatus. As soon as a single thread has been made, the tool is moved most accurately as far as the next division by aid of a measuring instrument of precision. Any threads finished by the aid of the lead nut according to the method above are obviously copies of the same; and as the nut is finished with practically mathematical accuracy by means of a precision measuring machine, any thread cut by the novel lathe will also be of nearly mathematical precision.

Other advantages over the old system may be mentioned, *i. e.*, the slide rest drive is placed as near as possible to the shears and the driving force thus acts directly under the tool post, and as near to the cutting point of the tool as it is possible to locate it. This produces the smallest possible twisting moment and gives a very direct drive. Again, whereas with previous lead-screw lathes the lead screw would frequently undergo heating and expansion because of the friction and pressure, this constituting a great drawback to accurate thread cutting, any heat evolved in this part of the mechanism of the De Fries lathe is conducted to the bed of the lathe and thus dissipated. Still another point is that in gap lathes, which are so much used on the continent, it was necessary to locate the lead screw in a very low position in order to clear the gap, and thus the driving force acted upon the slide rest at a great distance from the cutting tool. In the De Fries lathe this is avoided, as shown in the second illustration, since the lead nut does not have to extend across the gap and the splined driving shaft is located low enough to clear the gap. On account of the wear of the lead screw being obviously the greatest in the neighborhood of the face plate lathes of the old type lost their accuracy after a brief use, since there would be a change in the pitch in passing from a point near the face plate to a point where the lead screw had retained its original accuracy. In the De Fries lathe the lead nut is made up in several sections, any one of which may be renewed so as to correspond exactly with the other section. In this way the ability of the lathe to cut threads of accurate pitch can be maintained with no great trouble or expense.

In its general design and construction the lathe is built with the utmost care, every refinement of modern workmanship having been made use of. Special points have been made of neatness of construction, easy handling, beauty of appearance, and stability. The lathe is, by the way, heavy enough so that it is especially adapted to the use of high-speed steels. The lathe bed has T-shaped walls of extraordinary breadth and height, joined by means of hollow braces. The shears are broad and rectangular and special provision is made for oil-

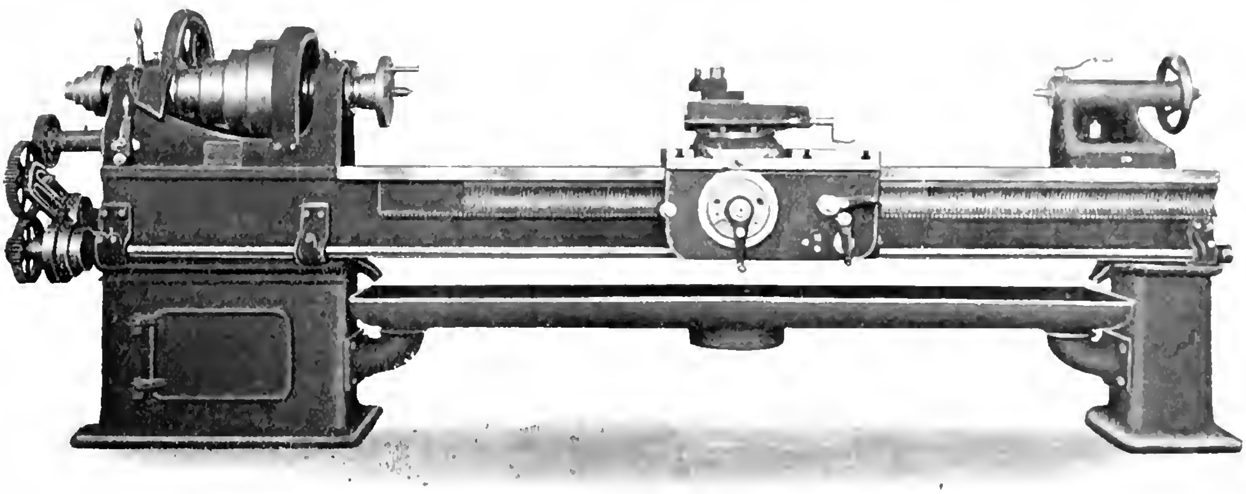


Fig. 1. De Fries Precision Lathe with Lead Nut, extending the Length of Carriage Travel, in place of a Lead Screw.

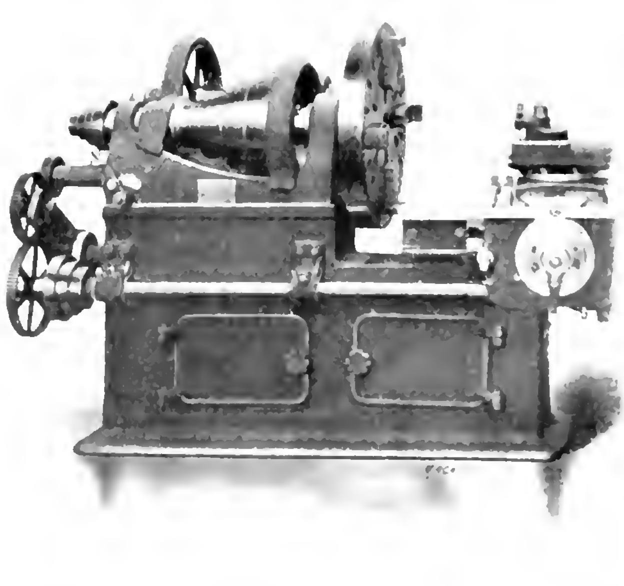


Fig. 2. The "De Fries" Principle applied to a Gap Lathe. With a Lead Screw on a Gap Lathe the screw has to be dropped below the gap, but not so with the Lead Nut.

DR. ALFRED GRADENWITZ was born at Breslau, Germany, May 18, 1875. He was educated at the König Wilhelm's Gymnasium (Preparatory School), Breslau, the Technical High School, Charlottenburg, and at the universities of Breslau, Freiburg, and Geneva. Dr. Gradenwitz has made a special study of science applied to industry and the progress of science and industry. Hence he has naturally become a contributor to the technical press; his contributions have been published in the leading trade papers of Germany, France, Spain, Norway, Denmark, Great Britain, and the United States.

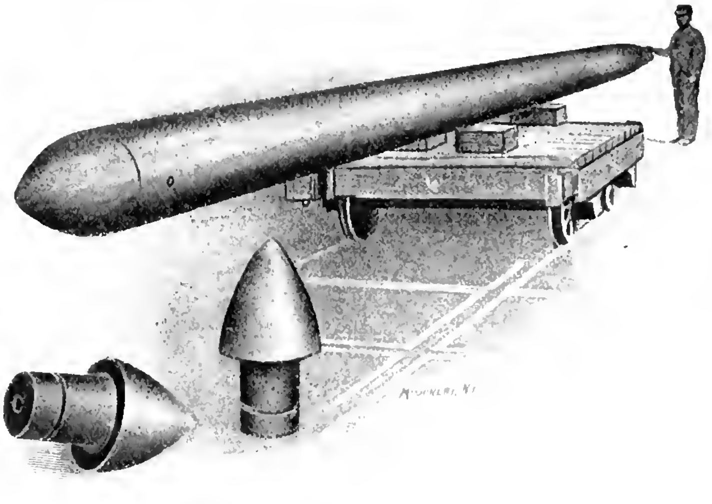
ing automatically, the oil coming in contact with the friction surfaces while the slide is moving.

The headstock is of pleasing shape, of strong and massive construction, provided with a four-stepped cone pulley for a wide belt. The gearing is protected by cast-iron covers. There are also tumbler gears located in the headstock by which the direction of feed is changed and there is a shift gear to enable extremely coarse threads to be cut. The lathe spindle is hollow and of crucible steel and the bearings are of phosphor bronze cut longitudinally into three parts spaced 120 degrees each. The thrust of the lathe spindle is taken by several chilled disks, between which are disks of a special composition. This arrangement was chosen after many experiments. The slide-rest and carriage have long, broad sliding surfaces so as to eliminate vibrations, even under heavy strains. Both the longitudinal and transverse feed screws are provided with graduated dials. The feed mechanism is of novel arrangement and either transverse or longitudinal feeds may be worked automatically or by hand, and the screw and rack feeds block each other so they cannot be operated simultaneously.

* * *

EFFECTS OF WAR ON THE ARTS OF PEACE—LOBNITZ ROCK CUTTER.

However much we may deplore the cruelty and waste of war, it is easy to show, paradoxical as it may seem, that war and the fear of war (and its consequences) have been powerful factors in stimulating inventive genius and constructive arts. The ancient armorers were, in effect, subsidized workmen who received very large sums for their products as compared with the prevailing prices for other goods. Hence the developing effect of war upon the metal-working arts. So in later years the building of battleships, rifled guns, mounts, the manufacture of the munitions of war, have undoubtedly reflected great benefits in civilizing influences, although the making of such is economically wrong. No cost is considered prohibitive by powerful governments in gaining a desired improvement, and the consequent experimenting and constructive work is happily not altogether waste effort—because of its beneficial effect on other lines of work.



Lobnitz Rock Cutter.

An interesting example of the beneficent effect of the arts of war upon the quiet pursuits of peace is shown in the cut which shows a huge rock cutter made by Lobnitz & Company, Renfrew, Scotland. This device is made for breaking up rocks under water as is necessary in harbor dredging operations, canal work, etc., and is found far more effective and cheaper than drilling and blasting operations. The cutter usually weighs from 10 to 15 tons and resembles an elongated armor-piercing projectile. The similarity is further carried out in that the head is made of steel of about the same characteristics as found in armor-piercing projectiles. These immense cutters or breakers are raised to a height of 6 to 10 feet and allowed to drop by a suitable releasing gear, the lifting apparatus being a steam winch or hoisting engine of special design for this work. As the cutter falls, the impact of its tremendous blow is concentrated upon a few square inches of rock surface, and the hardest granite yields readily to such forceful treatment. The fact that is of first importance in this connection is that until steel of the characteristics that make a successful armor-piercing projectile was developed, such a tool would have been a virtual impossibility since no ordinary tool steel could stand the punishment. This tool will probably play an important part in the completion of the digging of the Panama Canal, and this inspires the question: Who knows what the effect of high-speed steel will eventually be upon the peaceful pursuits of the world, and this was discovered and developed in the manufacture of armor plate and the machinery of battleships.

* * *

DRILL SPEEDS TABLE.

The table herewith, contributed by Mr. Walter Brown, Chicago, Ill., gives the speeds of drills in steel, malleable iron, cast iron, brass and tool steel, have been found most practical, in general use, at the Chicago works of the International Harvester Company. These speeds were carefully compiled after thorough trials in the works, and have been

SPEED OF DRILLS.

Size of Drill.	Revolutions per Minute.				
	Steel.	Mall. Iron.	Cast Iron.	Brass.	Tool Steel.
1/16	3650	4200	4380	6950	1790
1/8	1540	1770	1850	2930	755
3/16	1060	1240	1270	2160	520
1/4	740	850	890	1410	362
5/16	570	655	685	1080	280
3/8	460	530	550	875	225
7/16	370	425	445	703	182
1/2	310	356	372	590	152
9/16	270	310	324	513	132
5/8	240	276	288	456	118
11/16	210	242	252	400	103
3/4	188	216	226	358	92
13/16	170	196	204	323	83
7/8	156	180	187	296	76
15/16	142	163	171	270	70
1	134	154	161	255	66
1 1/8	115	132	138	218	56
1 1/4	104	120	125	198	51
1 3/8	92	106	110	175	45
1 1/2	84	96	101	160	41
1 5/8	75	86	90	145	37
1 3/4	70	81	84	136	34
1 7/8	63	72	76	120	31
2	59	68	71	112	29

found to be good commercial practice. It will be noted that the small drills are given a greater peripheral speed than the large drills. To compensate for the greater speed, the feed of the small drills is correspondingly reduced, this being found to give the most satisfactory results.

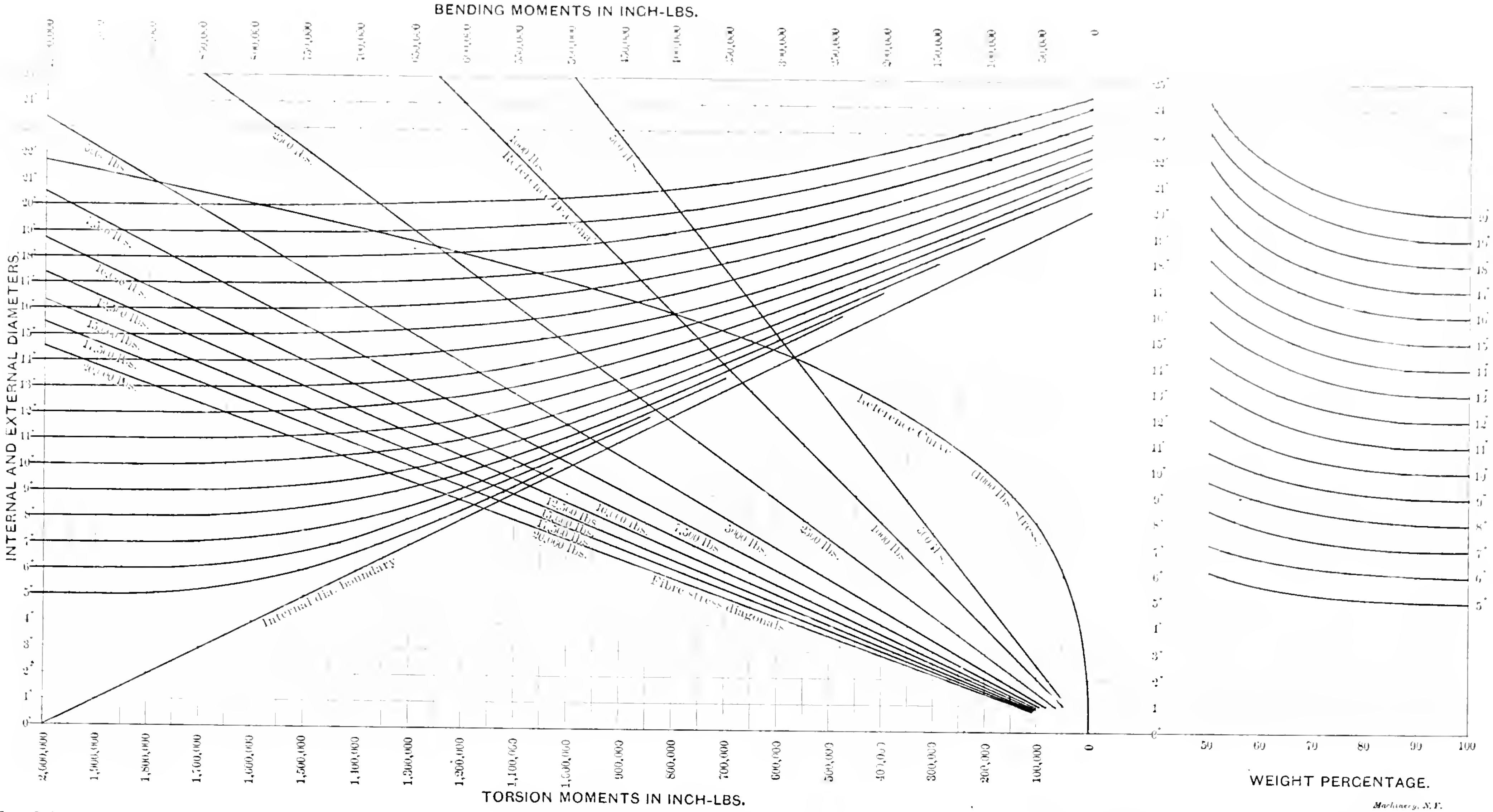
* * *

CHART FOR HOLLOW AND SOLID SHAFTS.

The diagram, next page, is one of the United States Navy standard charts of which several have been published in data sheet form in recent numbers of MACHINERY. The chart is for the purpose of finding the dimensions of shafts, especially of large size, as used in marine and heavy stationary engine construction. It can be applied to both solid and hollow shafts, when subjected to either torsional or bending stresses. The shaft diameters are found by first selecting the bending moment (at the top of the diagram) or the torsion moment (at the bottom of the diagram) which applies in the particular problem, and then proceeding as follows:

Solid Shaft in Torsion.—For a torsion moment of 1,600,000 inch-pounds and a maximum fiber stress of 7,500 pounds, follow the 1,600,000 torsion moment line vertically to the "reference curve;" trace the intersecting horizontal to the "reference diagonal;" trace the intersecting vertical to the 7,500-pound fiber stress diagonal and finally the intersecting horizontal to the vertical scale at the left-hand edge of the diagram, finding 10.27 inches diameter for the shaft.

Hollow Shaft in Torsion.—First find the diameter of a solid shaft to carry the load, as above, and assume some inside diameter. Suppose the outside diameter for a solid shaft is



found to be 10 inches and the inside diameter of a hollow shaft of the same strength to be assumed at 7 inches. To obtain the required outside diameter of the hollow shaft, start at the left at 7 inches and follow the horizontal line until the internal diameter boundary diagonal is reached; then proceed vertically upward until the curve is intersected which starts at the 10-inch point on the scale at the left, and read the diameter corresponding to this point of intersection. The diameter found is 10.75 inches; a shaft of this diameter, and with a 7-inch hole through its center, would have the same torsional strength as a solid shaft 10 inches in diameter. Again, if the central hole were to be 8.75 inches diameter, the outside diameter would have to be 11.5 inches in order to give the same strength as a solid 10-inch shaft. The diagram is so constructed that all shafts having external diameters bounded by the curve starting at 10 inches at the left and having internal diameters bounded by the diagonal starting from 0 at the left, are equivalents, and the same is true for curves starting from other points on the scale at the left. The vertical height from the diagonal bounding the internal diameters to the curve bounding the external diameters, is the actual wall thickness. drawn to a reduced scale, and is useful as giving a graphic comparison of the various equivalent shafts.

Weight Relation of Shafts.—To find a hollow shaft to have 50 per cent. of the weight of its 10-inch solid equivalent: Follow the 10-inch shaft curve in the small diagram at the right to the point of intersection with the 50 per cent. vertical line; then proceed horizontally to the 10-inch diameter curve in the large diagram at the left, which it intersects at the sought-for external diameter of 12.125 inches; and finally, dropping vertically down from the intersection point to the internal diameter boundary line, gives a diameter of 9.75 inches for the hole.

***Shafts Subjected to Bending.*—Proceed as before, but use the bending moment scale.**

LETTERS UPON PRACTICAL SUBJECTS.

WONDERFUL TAPS AND DIES.

Editor MACHINERY:

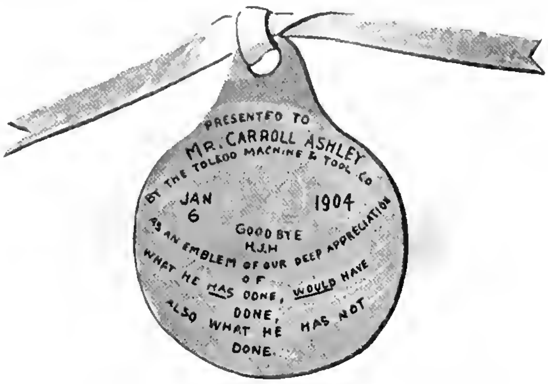
Recently an English daily newspaper of good reputation for reliability announced with befitting seriousness that taps and dies were now made so small that they could tap the human hair. After reading this I pictured to myself the advertisements of future tonsorial establishments: "Why have short hair? Tresses lengthened in any degree by our new process. Threads warranted without backlash and not to strip." Indeed, the prospect seemed so rosy that I thought of going in for the business myself and of getting the necessary kit. But, unfortunately, like the majority of the wonderful announcements in this "something scientific" column, there was neither the price, maker's name, or any practical information given for these useful (?) tools. However, if you know where I can get any of these I should be very glad of the information under "How and Why." When a paper wanders out of its depth it should be careful as to the source of its news.

McANIC.

A LEATHER MEDAL.

Editor MACHINERY:

Since we were "knee-high to a grasshopper" we have often heard the expression: "You ought to have a leather medal," More especially is the expression used in the machine shop, but have any of the readers of MACHINERY ever seen one? Methinks not a great many, not perhaps that some of you have not deserved one many times, but don't it recall to your memories many incidents of shop life—some humorous and some otherwise—just to remember some certain event, when for doing something famous or infamous you were threatened with the bestowal of a "leather medal"?



A Leather Medal given to Mr. Carroll Ashley, as a token of good fellowship, when leaving the Toledo Machine & Tool Co. after a seven years' service.

I take pleasure in sending you a photo of an identical "leather medal"—the real thing—not perhaps a thing of beauty, but it may be a joy forever, to me at least, as whenever I recall the episode of its presentation, I smile. It is made of four-ply unadulterated leather, a neat bow of "belt lace" gives it a machine shop effect. Though the inscription is rather vague it seemed to fill the bill. As much pomp and ceremony were used on its presentation, as if the recipient were going to be presented with a house and lot, and, in the same spirit, I endeavored to answer the presentation speech (which was long and quite flowery) just as if I had received the real estate. However that may be, the fact remains that I am the possessor of a real "leather medal;" if any of the readers of this journal can make a similar boast, I might be tempted to exchange condolences with him.

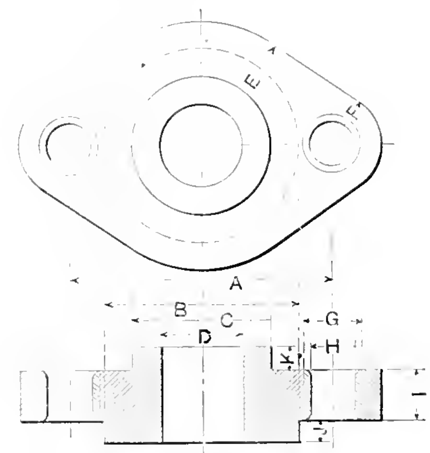
CARROLL ASHLEY.

Rochester, N. Y.

"LABOR-SAVING SCHEME FOR MAKING DRAWINGS."

Editor MACHINERY:

In Mr. C. W. Putnam's article "Labor-Saving Scheme for Making Drawings" in the September number of MACHINERY, I do not think he has chosen a very good illustration of the use of templates in the drawing-room. He was obliged to make a pencil-drawing in the first place. Then, while he was cutting out the template, he could have put a piece of tracing cloth over it and traced it, or this would have been a good job for the blueprint boy. Letters would then have been put on for dimensions, and while he was packing up his five sheets of tracing paper with the carbon sheets between, a row of columns could have been ruled off under the figure. At the head of the first column could be put "No. of Gland," and the letters corresponding to the dimensions at the heads of the others. He would then have something permanent and it would have taken little longer, if any, than for him to make his first five copies. It will take no longer to fill in the dimensions for the different size glands on the tracing than it would on his sketches, and if he printed the same title, as shown, on each sheet he would be left far in the rear before he had made the five hundred. I was about half an hour making the drawing for the accompanying cut; how many carbon tracings of his first five hundred could Mr. Putnam have made in that time?



NO. GLAND	A	B	C	D	E	F	G	H	I	J	K
60	$4\frac{3}{4}$	$3\frac{1}{2}$	$2\frac{17}{32}$	$1\frac{1}{4}$	2	$\frac{7}{8}$	$1\frac{1}{16}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{8}$

Machinery, N. Y.

"Labor-saving Scheme for Making Drawings."

I object to putting pencil drawings out in the shop for several reasons:

First, it is my experience that they are so hastily made that many of the important dimensions are often omitted, causing the workman, or perhaps the foreman while he stands around, to run back to the draftsman, or his chief, and interrupt him in some important calculation. Second, mistakes are more common on pencil tracings than on finished drawings. Third, if a workman makes a mistake on the work he can easily change the figure on a sketch, and sometimes does. Fourth, if the sketches are ever returned to the drafting room, which is doubtful, they are covered with grease and dirt and badly mutilated. Fifth, the sketches are generally of all sizes and shapes and are very difficult to file away or put anywhere where they can be readily found when wanted.

While it sometimes becomes necessary to use such sketches let us avoid it wherever possible. While I believe in doing

just as little work as possible, and that in the quickest and cheapest way we can, do not let us do it in such a way as to cause us weeks of sleepless nights and to be "blessed" by everyone connected with the concern we are working for, some time in the future.

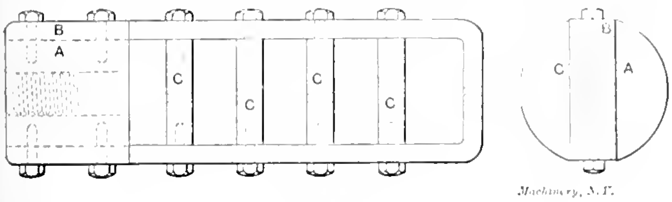
Templates can very often be used to advantage, but great care must be taken to get the work accurate. One cut out of cardboard or sawed from a ¼-inch board, is not good enough for complicated machines, such as a loom, drawn one-fourth size. It should be laid out on zinc under a magnifying glass and then filed up by a man who can work right to a line.

Worcester, Mass. H. A. Houghton.

WIRE STRAIGHTENER.

Editor Machinery:

In reply to inquiry by "Connecticut" for a wire straightener I send sketch and description of one I made about seven years ago to straighten ⅛-inch spring wire. It consists of a cast iron piece, *A*, fitted to the spindle of a speed lathe, and having two slots milled on the side for the piece of machinery steel *B*, which is bent U-shaped as shown. This frame holds a number of tool steel pieces (in this case four), which have



Wire Straightener.

holes drilled through them slightly out of center. After being hardened, drawn and the holes lapped to smooth them, they are assembled on the frame so as to bring the small holes in the position shown. One end of the wire is pushed through the four holes and through the hollow spindle of the lathe until it can be grasped with a pair of pliers, when the lathe may be started and the wire pulled through slowly.

New York. H. J. Bachmann.

HOW BILL CHANGED HIS JOB.

Editor Machinery:

One of my old shopmates came in to see me the other day. He had been away from the shop for two years or more and I had not heard a word from him in that time and I was cordially glad to see him. He wasn't much of a machinist; he never wore overalls or a jumper, and he used to turn his shirt away back from his neck and cut off the sleeves at the shoulder, and he didn't look like a machinist any how. He had been in the shop two or three years and he never got over $12 a week, and one day "he chucked up" his job and lit out—said he was going to see if he couldn't get a living at something that suited him better, or that he was better suited for, and as soon as he came in the other day, I saw at once he had found it. He had on a blue suit, not the "dollar-down-and-a-dollar-a-week style," but one that looked as though he had been melted and poured into it. A nice yellow chain hung out of his vest pocket and I knew Bill well enough to know there was a watch to match on the other end of the chain. He had on a clean collar and he looked like a man who had found prosperity.

"Well, Bill, you look as though you had struck oil," I said as we shook hands.

"No, but I have struck something that is better than oil and that is a hole that fits me," and then he went on and told me what he had been at.

When he "jacked up" he had no idea of what he was going to do and he took a job as deck hand on one of the steamers between Fall River and New York at $20 a month, and put in three months at it. Then went two trips as a coal passer and fireman on one of the big ocean liners at a pound a trip. He made two trips and no amount of money would tempt him to make a third. Then he shipped as fireman on a United States transport to Manila at $55 a month. That was a good thing, and he made three trips on her from San Francisco to Manila and return. Here he found that in order to cut any ice, he must be a union man, and so he joined the Fireman's Union and shipped for the Yukon River at $90 a month. Just before he went, he saw an illustration of the power of a union that will stand repeating.

An English firm had taken a contract to carry the United States mails from San Francisco to some foreign port and by the contract the steamer must be manned by American seamen, so the captain let his "long-haired boys" (Chinese) go and came up to the hall of the Fireman's Union to get a new crew. The captain had but one eye, and he called out the master fireman and says, "I want a crew of eight good firemen and I will pay seven pounds five shillings per month." This was a big price for an English boat, but it did not go at all.

"No you don't, if you want a crew out of this hall, you will pay ten pounds straight.

"What!" said the captain, and the mate who was with him roared, "What! pay a lot of greasy coal slingers two pounds a month more than I get; I won't stand that."

The captain started off and saw the British consul, only to be told that if he had taken a mail contract with that clause in it, he must take union men, and take them he did at ten pounds a month.

After three months on the Yukon, Bill struck a berth as second engineer at $110 a month, and although he had no papers, he held it till he could some back to 'Frisco and get passed. His machine shop training told in the examination and he got his papers and then came East to see some of his old friends and to go out as second engineer with a new boat just being finished.

"And now," said Bill, "if you know of a machine shop where I can earn $110 a month, a clean bunk and three squares a day, I am ready to talk, but till then, good-bye."

Bill has gone, but his experience lingers with me yet, and I can't help thinking how nice it would be if all the boys could find a hole that they fitted into as well as Bill has.

A. P. Press.

THREE-PIECE ELLIPSOGRAPH.

Editor Machinery:

To test the principle of an elliptical chuck we made the model shown herewith by means of which it was possible to trace with a stationary pencil, an ellipse of any size or proportion, on the revolving platen.

Fig. 1 is the base or stationary part, and it consists of a piece of 1¼-inch pine about 16 inches square, having a slot

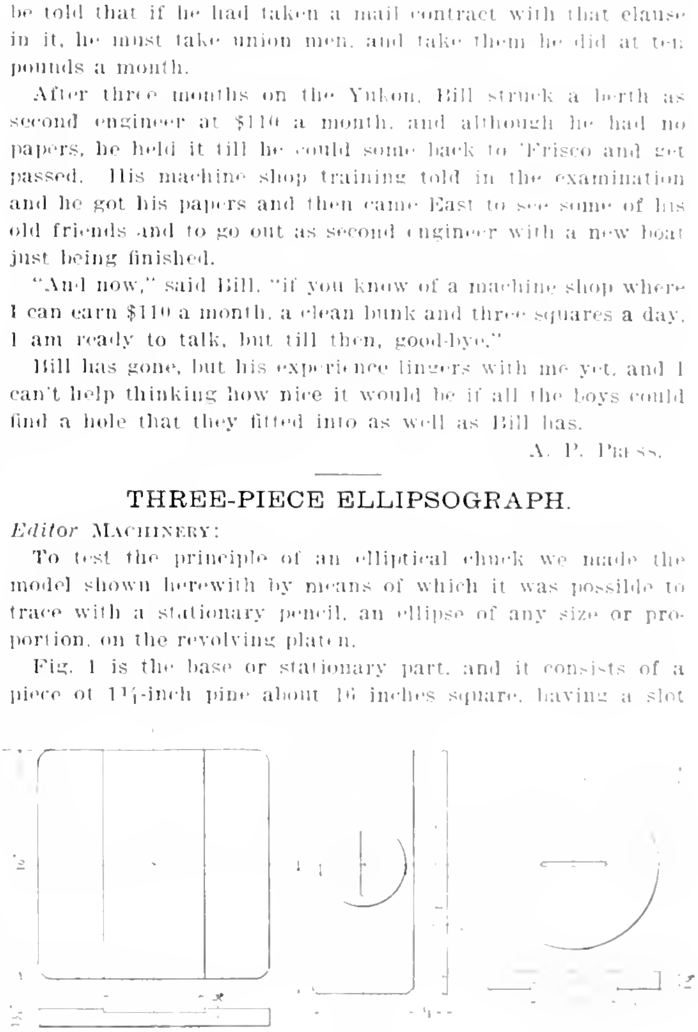


Fig. 1. Fig. 2. Fig. 3.

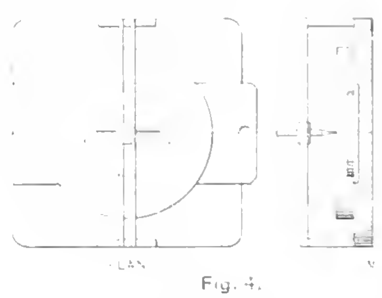


Fig. 4.

Three-piece Ellipsograph.

about 7 inches wide and ¼ inch deep across the center of the upper side. Into this slot is placed the piece for adjusting the eccentricity of the ellipse. This part is shown in Fig. 2 and consists of a piece of ¼-inch pine with a disk 6 inches diameter and ½ inch thick attached to its upper side. Fig. 3 shows the platen, which is 12 inches diameter, with a groove 6

inches wide and ½ inch deep across its under side. This groove fits over the 6-inch disk, shown in Fig. 2. The whole apparatus is held together by a large wood screw passing through Fig. 2 and Fig. 3 into the center of Fig. 1. Two small strips are supported from the base and run diametrically across and about 2 inches above the platen. A small block supporting a lead pencil, slides between these strips, as shown in the assembled drawing.

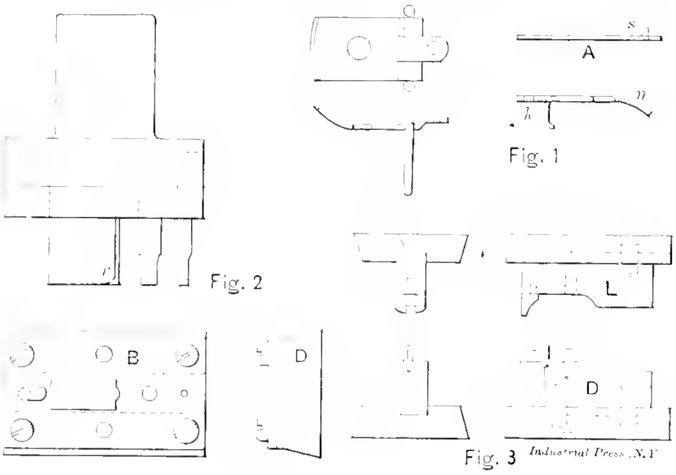
To operate a paper is tacked on the platen. The piece shown in Fig. 2 is drawn to the right according to the eccentricity desired and the pencil pushed away from the center, according to the minor axis desired. Upon rotating the platen by hand an ellipse will be traced. As any proportion between the minor and major axes can be obtained the apparatus was later used with a cutter instead of a lead pencil, which gave good results in cutting photographs, etc. J. D. Adams.

Phoenix, Ariz.

MAKING A SPRING LATCH.

Editor Machinery:

I send you herewith descriptions and drawings of dies for making the spring latch shown in Fig. 1. Fig. 2 shows the blanking punch and die, which is of the ordinary follow type, the only special feature being that the punch is rounded at *r* to start the two wings for curling. *D* is a cross view of die,



Making a Spring Latch.

while *B* is a plan view. *A*, Fig. 1, is the blank as it comes out from this operation. Fig. 3 is the splitting die for turning up the two ends as shown at *k*, Fig. 1. The blank *A* is laid on the die *D* with the bent ends *s* pointing down over the bending forms *I*. The punch *L* descends, bending the ends down as shown at *k* in the lower view of Fig. 1, and curving the back of the latch as shown at *n*.

We will next consider the staple die, Fig. 4. The wire being laid in the die as shown, the punch descends and the knife cuts the wire off at *C*. The punch, which is ⅛ inch shorter than the knife, pushes the wire, which is left lying in the groove against the stop pin *G*, down into the forming grooves *O O*. Then the punch rises and with it the spring stripper *R*, thus ejecting the staple when the wire is inserted in the die again and the operation repeated. This die is used in an inclined press, which causes the staples to fall by gravity after being formed. End views of the punch and die are shown at the right.

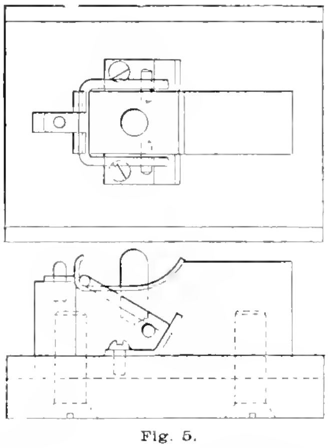


Fig. 5.

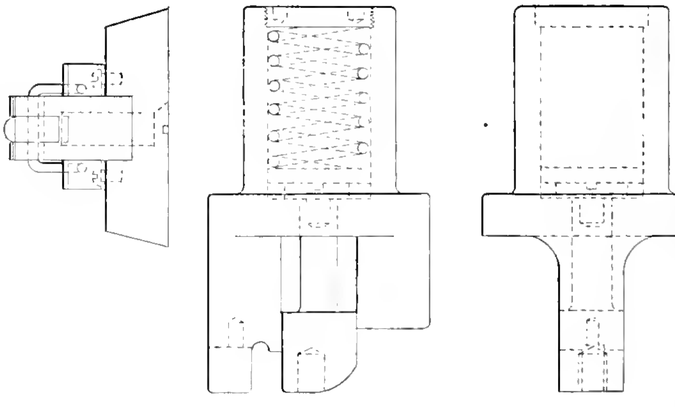


Fig. 6.

We are now ready to curl the two wings *k*, Fig. 1, over the staple, and for this purpose the punch and die, Figs. 5 and 6, were made. The punching *A*, Fig. 1, is laid on the die as shown with the ends resting on the holders on either side of the die. The punch in descending strikes the blank with the spring foot, which holds it in position while the curling punch coming on down forms over the ends *k*, Fig. 1, around the staple. At the end of the stroke, the tongue is formed over

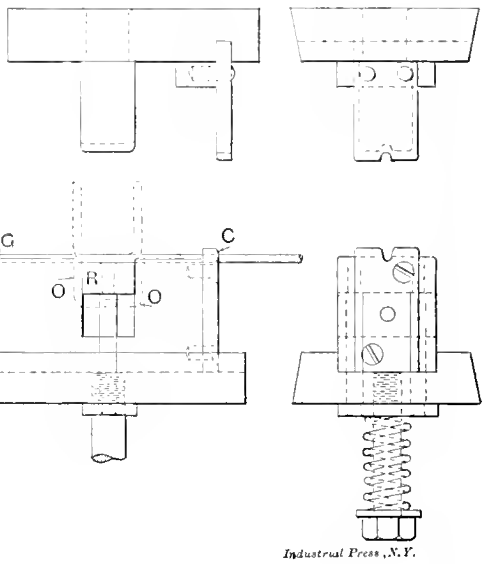


Fig. 4. Staple Die.

the raised die by the punch, thus completing the latch. I have not thought it necessary to explain the construction of the tools as it is made quite plain by the drawings.

H. R. H.

CATCHING THREADS AND GAGING THE DEPTH.

Editor Machinery:

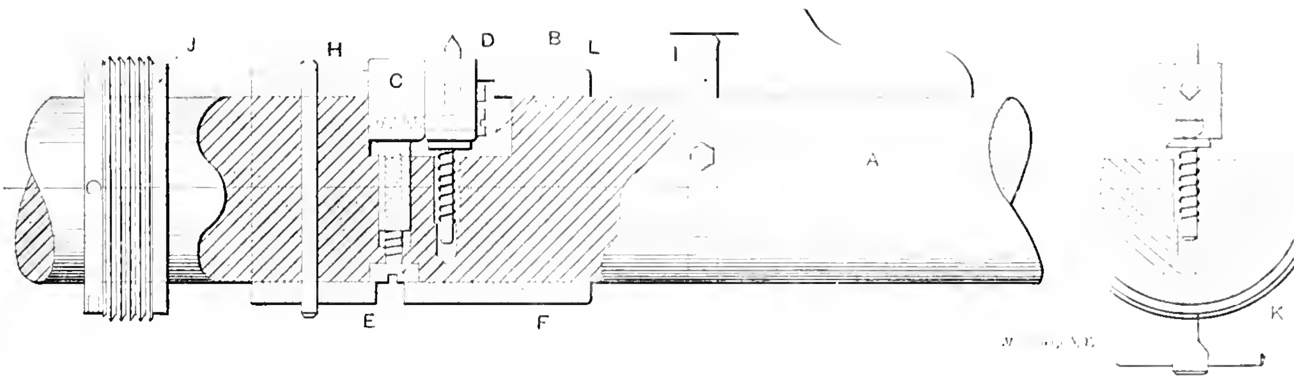
I noticed the remarks by John A. Burgess in the June issue and it carried my thoughts back to the days when I was an apprentice. As regards the knot holes in the wall, they were about the same, and I also had to take a broom in the winter and sweep the snow off the lathe after a storm that leaked through these same knot holes or some other aperture that was more convenient for the sparrows than the men.

Now, in this same shop I learned a method of cutting threads that may be interesting to your readers, and it was this: I used to carry the carriage back without stopping the lathe at all. I don't mean on a thread that was the same pitch as the lead screw, but I mean any thread, and I also mean long ones where the carrying back of the carriage was a great saving of time, and I very seldom made a mistake. It may seem a difficult operation, but it is simple when the idea is understood. All it requires is to regulate the speed at which the carriage is run back, by the length of the screw and the pitch. Now I used to put a chalk mark on the faceplate and another on the lathe bed at the end and beginning of the thread and far enough away to give me a chance to feed in the tool to the depth required. It is just the same as suggested by Mr. Burgess, only there are points that require a little explanation, for there are a great number of men still

going around that know of no other way than pulling back by hand or power, both of which are a lot of lost time. For example, if I am cutting 8 threads per inch and the tool has reached the end of the thread and my mark on the faceplate has come into view I disconnect the split nut, and with the lathe still running I carry back the carriage at the same time, counting in my mind 1, 2, 3, 4, etc., every time the mark on the faceplate comes in to my view. If I reach the starting of my thread in time to catch the fourth revolution of the faceplate I connect nut again and start afresh; if not I count up to 8, do the starting again from that point.

Now this brings me to another point, and that was the plan I employed to set the tool to the required depth in cutting. When I took the first cut I would notice in what position the handle stood, and we will say that it stands straight up. I would say to myself that it was at 12 (or you could call it anything you liked, but I used to say 12). Now the next cut I would call 5 past 12, and the next would be 10 past, and when it was 15 past the handle would just be one-fourth the way around. You see the handle I treated like the hands of a clock, and with a little practice it is surprising how accurate one can be, and when he gets familiar with the spacing he can finish the thread by counting single minutes. Now this may seem crude to some of your readers, and to some it may be new, but judging by the number of readers of MACHINERY about here you must have both kinds. To those who try this method they will be surprised at the rapidity at which they can cut threads compared to what they did before.

BARNEY.



Figs 1 and 2. Boring Bar for Chasing Threads.

BORING BAR FOR CHASING THREADS.

Editor MACHINERY:

Herewith is a sketch of a combined boring and thread-cutting bar, which was designed for boring and threading the large crossheads of the engines, which were built for the Brooklyn Rapid Transit Co., Brooklyn, N. Y., by the Allis-Chalmers Co., Scranton, Pa. The holes in these crossheads, when finished, were 8 inches in diameter by 12 inches long and threaded 6 per inch. The material used was Bessemer steel.

The bar *A*, in Fig. 1, is 8 feet long by 5½ inches in diameter, with a portion, marked *L*, cut away and two holes drilled to receive the feed slide, and the pawl which retains the tool block in position, as is shown in Fig. 4. The sleeve *B*, Fig. 3, is fitted to the bar and secured by the pin *H*. This sleeve is slotted to allow the feed slide *C* and the tool block *D*, Fig. 1, to move to the work and also to hold the tool block rigid, when cutting. The slot is cut sufficiently off the center to allow the tool block to be swung to one side when the cut is through, as shown by the dotted lines in Fig. 2. The workman, by disengaging the lead nut, can run back the lathe carriage to which the work is bolted, turn the tool block back into cutting position, feed the tool out, by means of the wrench *K*, Fig. 2, and take the next cut, repeating this until the hole is finished. The threaded collar *J*, Fig. 1, is a gage for sizing the thread without taking the bar out of the lathe, being made the exact size of the thread on the piston rod. *I* is the cutter (under the setting gage) for boring the hole before chasing the thread. The sleeve *B*, overlaps the head of the feed screw *E*, and takes the end thrust. The tool block *D*, swings on the pin *L*, and is held in the desired posi[illegible] the flat spring-pawl *F*. The merits of this tool may [illegible] at a glance, and I will say that it made a very good job of the crossheads.

D. L[illegible]SAY.

Plainfield, N. J.

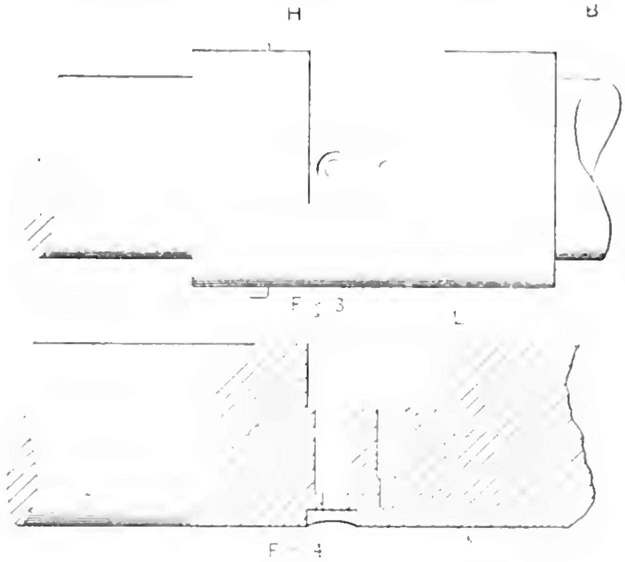
CHANGE GEARS FOR DIAMETRAL PITCH WORM TEETH—CUTTING MULTIPLE THREADED SCREWS.

Editor MACHINERY:

While it is customary to design worm gears by the circular pitch system, for convenience in finding the proper change gears for threading the worm in a lathe, yet occasionally the workman may have the problem of calculating the change gears required for a worm of the diametral pitch system. In such cases it may conveniently be done as follows. Multiply the ratio of the pitch (in threads per inch) of the lead screw of lathe, to the diametral pitch of wormwheel, by 3.1416 or (to avoid decimals), by 3 1-7. This will give the ratio of the stud gear of lathe to the screw gear. For example: Required the change gears to thread a worm of 6 D. P. the lead screw of lathe having 4 threads per inch.

$$\frac{1}{6} \times \frac{22}{7} = \frac{88}{42} \quad \begin{array}{l}\text{gear on stud.}\\ \text{gear on screw.}\end{array}$$

The above gears will give the required lead, with an error of not quite 0.0002 inch in the thread of worm, and is caused



Section of Boring Bar for Chasing Threads

by multiplying by 3 1-7 instead of 3.1416, which would give a fraction of a tooth or $\frac{87.9648}{42}$. Perhaps a better way to remember the rule would be: Multiply the threads per inch in lead screw of lathe by 22 and the diametral pitch of worm-

JOHN T. GIDDINGS was born in St. Johns, New Brunswick, June 18, 1865. He has a commercial education and is a graduate of the International Correspondence School. He served an apprenticeship with the Providence Machine Co. and the Rhode Island Locomotive Works. Besides these concerns he has worked for the Builders' Iron Foundry, the Brown & Sharpe Manufacturing Co., the Corliss Steam Engine Company, the American Screw Company, the American Ship Windlass Co., and others. His specialty as a machinist is lathe work; and as a draftsman, hoisting machines and windlasses.

wheel by 7. This will give the ratio of stud gear to screw gear. The above rule assumes that the stud of lathe makes the same number of revolutions as the lathe spindle. If it does not, then the equivalent pitch of lead screw should be used as explained by Mr. Fred H. Colvin in the November, 1903, issue of MACHINERY.

When a multiple threaded screw is to be cut in a lathe, if the faceplate is not divided into the required number of slots for shifting the driver (or dog) the usual method is to disconnect the change gears and either move the spindle through the required part of a revolution, or the gear on the lead screw may be moved enough to cause the required amount of tool travel for the next groove to be cut. For some cases this may be more conveniently done as follows: Calculate the amount of travel required for the tool to cut the next groove, then (the lathe being stopped) disconnect the lead screw half nuts, and move the carriage by hand the required amount, provided, of course, that the lead screw is of such a pitch as will admit of this method. For example: Required to thread a triple-threaded screw of $\frac{3}{4}$ inch lead. The lead screw of lathe has 4 threads per inch or $\frac{1}{4}$ inch lead. After cutting each groove, disconnect, and move the lathe carriage one thread of the lead screw, this will bring the tool in the proper position for the next grooves. For some cases this is not quite so easy, as for example: Required to cut 6 threads per inch, double; the lead screw same as before, $\frac{1}{4}$-inch lead. Then the lead of screw to be cut is 1-3-inch and the pitch of thread or the distance to move the carriage is 1-6-inch. We cannot move the carriage 1-6-inch and catch the thread with a $\frac{1}{4}$-inch pitch lead screw, but it may be moved 3-6 or $\frac{1}{2}$-inch, which will bring the tool in the proper position for cutting the second groove. For still other cases the pitch of the lead screw may be such as not to allow the above method to be used at all, but the principle having been explained the reader will have no difficulty in determining whether such is the case.

JOHN T. GIDDINGS.

East Providence, R. I.

FORMULAS FOR DIFFERENTIAL INDEXING.

Editor MACHINERY:

In differential indexing the index circle is geared to the spindle so that, as the crank moves, the index circle also moves either clockwise or counter-clockwise, depending on whether we use one or two idlers. This motion of crank and index circle at different rates, and in the same or different directions, allows us to cut any number of divisions, exactly, without compound indexing. This method is called differential indexing.

To obtain a formula for determining the gears necessary to cut a given number of divisions we proceed as follows: If N divisions are to be cut, the spindle will rotate $\frac{1}{N}$ turn between each division; also the distance traversed by a hole of the index circle $\pm$ the distance traversed by the crank equals the number of turns, or part of turn, of the index circle.

If, then, we let $x:y$ be the ratio of the teeth of gear on spindle to the teeth of gear on worm, and if the crank turns 40 revolutions to one of the spindle, we can then obtain the following:

$$\frac{40x + y}{N\,x} = \text{the number of turns of index} \ldots\ldots\ldots\ldots (1)$$

The approximate fraction $\frac{40}{N}$ ....(2) shows the number of turns of index to use. For $\frac{40}{N}$ we should use a fraction whose denominator is a factor of some index plate at hand. By placing the proper values in formula (1) we may readily obtain the proper gears. I will illustrate by showing how to obtain the necessary gears to cut 113 divisions.

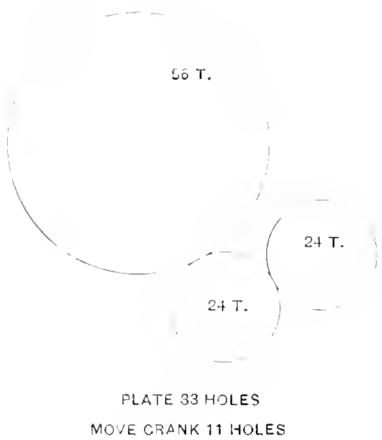


Fig. 1.

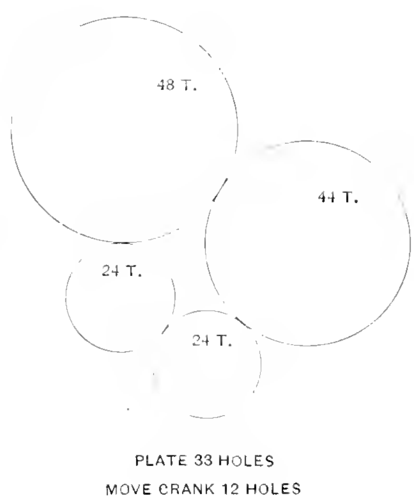


Fig. 2.

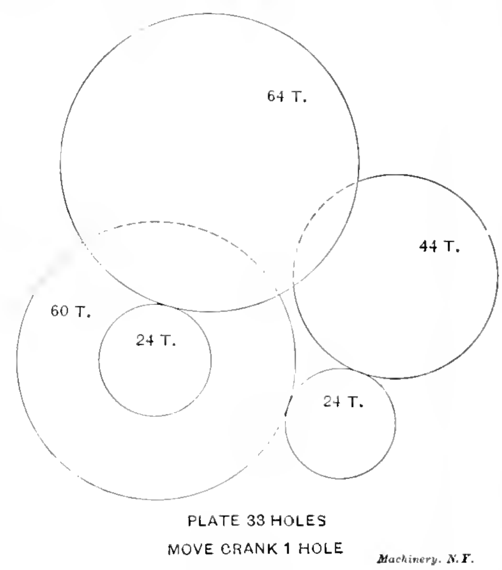


Fig. 3.

$$\text{Using formula (2)} \quad \frac{40}{113} = \frac{1}{3} \text{ nearly.}$$

$$\text{Using formula (1)} \quad \frac{40\,x + y}{113\,x} = \frac{1}{3}$$

$$\text{Solving, } 3\,y = -\,7\,x$$

Note that the sign of x is negative. This shows that only one idler is to be used, while if x is positive two must be used.

The ratio of the teeth on the worm gear to the teeth on spindle gear is 3:7

$$\begin{array}{cc} 3\,y = & -\,7\,x \\ & 8 \\ \hline 24 & 56 \end{array}$$

Use 24 gear on worm, 56 gear on spindle and one idler. Index on 33-hole circle spacing 11 holes or $\frac{11}{33}$ turns. See Fig. 1.

Often two or more sets of gears will cut the same number of divisions, depending on the number of turns of index taken. For example:

$$\frac{40\,x + y}{113\,x} = \frac{4}{11} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\text{Solving, } 11\,y = 12\,x$$

The sign of x is positive, therefore use two idlers.

$$\begin{array}{cc} 11\,y = & 12\,x \\ & 4 \\ \hline 44 & 48 \end{array}$$

J. O. Villars was born in Clarksville, Ohio, in 1873. His collegiate education was gained in Wilmington College, Ohio, and Haverford College, Pa. Since that time he has followed the profession of a teacher, having been assistant principal of Wilmington High School, Wilmington, Ohio, for three years, and now fills the position of instructor of physics and applied mechanics at the Williamson Free School of Mechanical Trades, Pa., in which position he has been for the past four and one-half years. In this school about 200 boys are receiving an education to fit them for the various trades of machinist, patternmaker, carpenter, bricklayer, steam or electrical engineer. The work of this school is very practical, the boys being apprentices and doing the work as they would in any well regulated shop. All the graduates are in demand at good wages.

Use 44 worm gear, 48 spindle, two idlers and index plate 33, using $\frac{12}{33}$ turns. See Fig. 2.

Suppose we wish to index 120 divisions, then

$$\frac{40x + y}{120x} = \frac{1}{3} \qquad \ldots\ldots\ldots\ldots (1)$$

$$3y = 0$$

This shows that with any index circle on which we may get 1-3 turn, we get 120 divisions, by using simple indexing.

Suppose we wish to space ¼ degree or 1,440 divisions,

$$\frac{40}{1440} = \frac{1}{36}$$

but we have no 36 plate. Therefore, use

$$\frac{40x + y}{1440x} = \frac{1}{33}$$

$$11y = 40x$$

Use two idlers compounding on one, with drivers 64 and 60, driven 24 and 44, index plate 33 and 1-33 turn. See Fig. 3.

Suppose we wish to space a vernier to read 5 minutes. By dividing 11 degree spaces into 12 parts we accomplish this. This would give $\frac{4320}{11}$ spaces in the circumference.

$$\frac{40x + y}{\frac{4320}{11}x} = \frac{1}{10} \qquad \ldots\ldots\ldots\ldots (1)$$

Solving:

$$11y = -8x$$

$$\frac{4}{44 \qquad 32}$$

Use 44 worm, 32 spindle, one idler and any index plate upon which 1-10 turn may be obtained. In this case use index plate 20, and 2-20 turn.

I believe this method should commend itself, especially where fractional indexing is needed, and where no table is given for the required number of divisions.

J. O. Villars.

Williamson School, Pa.

MAKING PISTON RINGS.

Editor Machinery:

Referring to the article in the October, 1903, issue on tools for turning and boring piston rings, written by H. H. Eshenshade, it occurs to me that in his engine he used the one

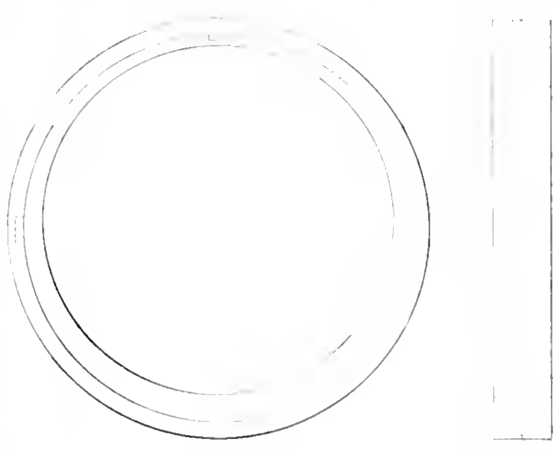


Fig 1. Making Piston Rings.

thickness of ring only, which, of course, is all right for a short-lived engine, but for fear that some one may think it the correct thing, I beg you to give me a hearing. Take for example the experience of the manufacturers of one high-grade engine covering a period of nearly forty-seven years. The conclusion at which they have arrived is that it is strictly right and proper to put in three rings, arranged in the manner shown in Fig 1. The inner one is called the bull-ring and is about 2 inches wide by ⅜ inch thick at the open side and ⅝ inch or ¾ inch thick at the other. Outside of this ring are the other two lying side by side. These are 1 inch wide by ⅝ inch thick all around. The inside of the bull-ring is not machined, the scale being left on for additional strength but the outside is turned and finished to diameter size. The outer rings are finished inside and out and must be parallel both in thickness and in width. Here comes in Mr. Eshenshade's bell chuck and it is certainly first class. The castings from which the rings are to be made should be bolted into it, and while the tool in the toolpost is turning the outside, they are bored out by an ordinary boring head with follower strung on the mandrel.

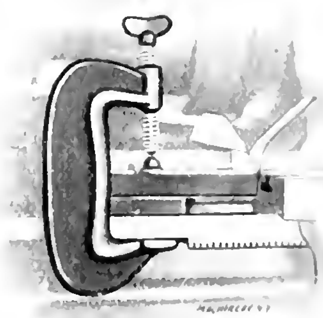


Fig. 2. Iron Clamped on Ways of Lathe to make a Position Stop for Carriage.

When this is all done and we have the exact size both inside and out, the front edge is faced off and we are ready to cut off the first ring. Now as every machine man knows that he cannot depend on a cutting-off tool to do its work exact and straight; it is, therefore, necessary to cut the ring about 1-64 inch wider than the desired finished width. After the first ring has been cut off we then face the front edge again and cut off another, and so continue until the entire blank is used up. After making one hundred or two hundred rings, we are ready to face the rough edge parallel with that already finished. This had always been a very slow operation, it being very diffcult to get them correct and interchangeable for width and at the same time keep the two sides perfectly parallel until the following plan was adopted.

The outer rings were bored and turned and cut rough to length before the bull-ring was made. Then when the bull-ring blank was on the face plate and it had been turned on the outside to fit the bore of the outer rings, and cut into sections up to the butt end of the casting, a section of this butt about ⅞ inch long was turned to a driving fit for the outer rings and the shoulder thus formed faced off perfectly square with a little clearance in the corner. One of the outer rings is then driven on with the finished side snugly against the shoulder, and an ordinary diamond point tool set for a facing cut. When the finishing cut has been taken on the first ring, and before the lathe carriage is moved, a block of iron is clamped on the ways of the lathe "bang up" against the end of the carriage as shown in Fig. 2, thus providing a position stop for the carriage. The carriage may then be run back out of the way, and the finished ring driven off, and another put on in its place. The lathe man then drops two thicknesses of ordinary paper in between the carriage and the stop piece, as shown in Fig. 2, and then takes a cut off the end of the ring. The slips of paper are then removed and with the carriage run close up against the stop, the finishing cut is taken.

Harry E. Wood was born in Fulton, N. Y., June 16, 1870. He served an apprenticeship with Frank Dilts, Fulton, N. Y., and has since acquired an extensive experience, having worked for F. W. Wheeler, Bay City, Mich., Industrial Works, Bay City, Mich., Russell & Co., Massillon, Ohio; Oswego Machine Works, Oswego, N. Y.; Ames Iron Works, Oswego, N. Y.; Dexter Folder Co., Pearl River, N. Y.; and others. Mr. Wood is an all-around machinist, tool-maker and designer, and has held the positions of gang boss and foreman. His specialties are steam engine work and paper working machinery. He spent some weeks at the Louisiana Purchase Exposition this summer in charge of an exhibit for the Dexter Folder Co.

Following this method I have faced off sixty-two 14-inch rings in 2¼ hours' time, and at the inspection every one passed O. K.

STEEL.

ACCURATE JIG MAKING.

Editor MACHINERY:

The subject of accurate measurements is one that appeals directly to every machinist and toolmaker and upon which two much light cannot be shed. In a large majority of the shops of this country the micrometer and the vernier are the only instruments used in determining whether work is made to the desired dimension, and thus these tools become the arbiters as to the accuracy of any measurements no matter how obtained, whether by screw or gage. Measurements of length and diameter within the limits of these tools are directly attained, but measurements of distance on a plane surface are not so readily found or proved until after the work is done. A method of measuring spaces on a plane surface was described by the writer in the October, 1902, issue of MACHINERY, and it was with the object of calling the attention of your readers to this method and with no desire to criticise the method described by Mr. Frank E. Shailor, in the July issue of MACHINERY that I wrote the letter that appeared in the August issue. I believe I stated that his method is a good one, but that I wished to call attention to mine, which I believe to be better—better because more generally applicable to the average shop. No method, however carefully devised, is of value unless care is taken in using it, and I venture to say ignorance or incompetence will cause errors as gross by one method as by another.

Mr. Shailor has written a letter in which he shows some ten chances for errors that I took in making jigs by the gage method of spacing the distance for bushings. I venture to say he has not read the original article carefully, for if he had he would not have advanced some of the arguments he did.

The first chance for error, according to his letter, was in placing the hole in the bracket central with the drill spindle. This does not appear to me to be a very difficult job, and is one that any good machinist or toolmaker can do without calling very heavily upon his skill. Since Mr. Shailor seems to think it difficult of accomplishment I will briefly state how it may be done: We will suppose all the play of the sleeve in the drill press is taken up and the bracket fastened to the frame of the drill press, then a short, fine-pointed centering drill is put in the chuck, and a center is very slowly and carefully made for the drill; next a short drill is used to drill the hole, which must be somewhat smaller than the bushing to be used. A boring tool is then put in the spindle of the drill press and the hole is bored central with the spindle. If Mr. Shailor will turn to the October, 1902, issue of MACHINERY he will find in my article on jig-making the description of a boring tool that is suitable for the purpose. The hole being bored, a chucking reamer is next run through it, to size it, and it is ready for the bushing.

A second chance for error, he thinks, is in not having the hole in the bushing concentric with the outside. Well, this would apply to the bushings used in any jig, and to me this appears as a trivial objection since Mr. Shailor in his July article gives minute directions for making the bushings for jigs.

The third chance for error is in the fit of the drill and the hole in the bushing; that is, they should fit each other perfectly. There is no doubt about that and it is another mechanical job not very difficult to perform. This is also a condition that must prevail when making any jigs for interchangeable work. It would not seem difficult to make a single bushing to do this when some jigs contain dozens of bushings, each one of which must have its exact size.

The fourth chance is in the fit of the outside diameter of the bushing and the hole in the bracket. This, again, it seems to me, to be trivial since it is a matter that only requires the skill sufficient to find the size of the hole and make the bushing size accordingly; a toolmaker who cannot do this much is not worthy the name.

Fifth, the spindle of the drill press must be at right angles with the table of press in every direction. This is also true of any method of making holes whether upon the drill press or against an angle-plate. No good toolmaker will take anything for granted in the machine line, since he has chips and dirt to look out for in any work he is doing. Any inaccuracy that may exist in this respect is readily found by using a piece of wire as a sweep, and is readily corrected.

The sixth chance for error is put in the form of a question which Mr. Shailor answers to his own satisfaction at least. It is: "What assurance have I that the drill continues straight through the plate?" Answer: "None whatever." Oh! yes I have, I have the assurance that comes from long practice and of doing it repeatedly. Twist drills sometimes run out, as it is called, for several reasons, the first and most common cause being that they are not properly centered and started, the second that they are crowded through the work and caused to deflect by a pressure that buckles them, especially if they are of small diameter. If it were a serious or difficult matter to drill a hole true, even to considerable depths, then I am afraid it would not be of much use to make drill jigs, since they are used solely to guide drills in the work. That it is not so is evidenced by the fact that holes of small diameter and great depth are quite common, such as, for instance, the holes that are drilled in drills having oil feed, gun barrels, etc. A drill that has been started into a piece of work true and to a depth equal to its diameter will continue to run true if it is not crowded and it encounters no variation in density of metal; that is, no holes in the work. Should it do so, however, it gives instant warning of the same by the vibration it causes in the work or the drill itself. Mr. Shailor thinks that sensitive drill presses are more sensitive to spring than any other machine, and for that reason a drill will not continue straight through a piece of work. This is undoubtedly true if sufficient pressure is put upon the drill; it is for that very reason that a small drill is first put through the work which will not require sufficient pressure to spring even a more delicate machine. The greater portion of the pressure comes upon the point of the drill and when the larger drill is used the pressure is thereby eliminated.

The seventh chance for error, he says, is when the holes are opened up with a half-round center reamer having but one cutting point, since cast iron is full of grit and that it requires but a small particle of grit to cause the center reamer to change its location. The statement that cast iron is full of grit is an astonishing one to me. Grit, as I understand the word, is a product of the rocks and stones, and if it were present in any quantity in cast iron but few if any tools could be used upon it. Cast iron, when it comes from the mold, is covered on its surface more or less with the sand from the mold, but this is usually removed by the tumbling barrel or by pickling; in any case such tools as jigs are made of finished castings, and it is only with the interior part of the casting we have to deal. Brown & Sharpe Mfg. Co. in their catalogue give an illustration of a gear tooth cutter that has cut a number of teeth of 4-pitch that is equivalent to cutting a length of 7,472 feet in cast iron. I believe that this particular cutter must have encountered very little grit to have done this amount of work. The object of using a half-round center reamer is that it tends to keep true to the hole it is opening out and it requires not a little effort to cause it to deflect.

The eighth and greatest chance is in opening the holes with a larger drill, the danger coming from having one lip of the drill the least bit longer than the other. This is provided for by the half-round center reamer which opens the mouth of the hole to a diameter equal to the reamer size and therefore larger than the drill. When the drill is entered into the hole it can cut only on the outer edges of the lips since the angle of the center reamer is 60 degrees, while the angle of the lips of the drill (to a transverse plane) is about 30 degrees or less; the drill is therefore entered a considerable distance into the work before the full size chip is taken.

It is my experience that a drill having one lip a little longer than the other will cut somewhat larger than its size, but that it should cause it to run in any direction other than that

of the least resistance is to say the least doubtful. But since this chance seems so objectionable to Mr. Shailor, I call his attention to the fact that the hole can be opened by a counterbore, and as he has said nothing against this way of opening the holes I take it for granted that it is at least feasible in his opinion.

The ninth error is in sizing the hole with a reamer. If the holes were sized with a hand reamer there would be some weight to this objection, as a hand reamer cuts only on the face of the tooth, but the holes should be opened with a machine reamer which, having it start in the hole given it by the center reamer, will follow true, as these reamers cut only on the end and not at all on the sides.

The tenth chance is the personal error in calipering the gages. Personal error, I take it, means the inability to measure twice alike and also the inability of two individuals to attain the same degree of pressure on the measuring instruments. If this condition existed there would be no such a thing as making interchangeable work, since an inch at one time would to the same man be more or less than an inch at some other time, and the product of one workman would not agree

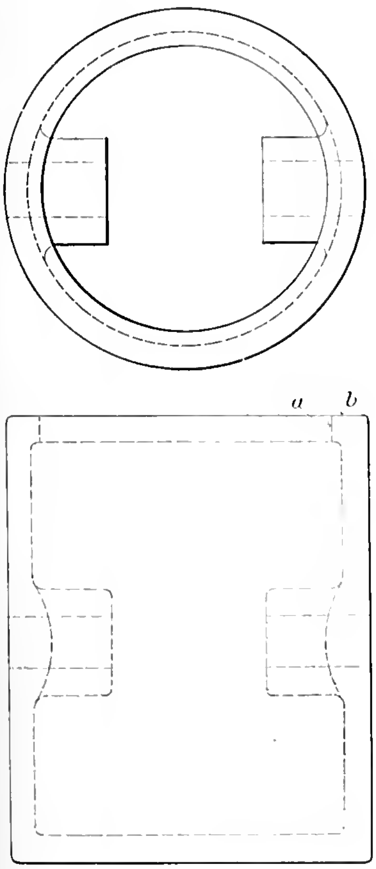
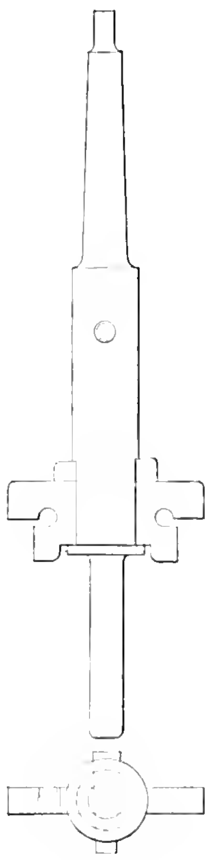


Fig. 1.



Industrial Press, N.Y.

Fig. 5.

with that of another. The facts are that men who have been accustomed to close measurements agree so perfectly with each other that when a question of this kind arises it generally leads to a test of the instruments. It is true that the pressure given the instrument may vary from one man to another slightly, but they in that case vary the initial pressure on their instruments and thus attain the same results. Mr. Shailor seems to think I add one gage on top of another in spacing the distances, but such is not the case. If I wish to move the plate one inch, then the gage would have the length to give the inch of distance required; if I next wished to move the plate one half inch further, then a gage one-half inch longer than the other is used. Errors are not then multiplied, as he seems to think.

His doubts as to whether jigs made by the method I have described could be duplicated amount to nothing, and I will state that they can be exactly duplicated if the same gages are used in both jigs and, moreover, they can be duplicated the same day or ten years hence, which is more than can be said of any milling machine screw that receives anything like the usual service given in most machine shops. J. R. GORDON.

Brooklyn, N. Y.

JIGS AND TOOLS FOR MACHINING SMALL PISTONS.

Editor MACHINERY:

I send herewith drawings of a jig and tools for machining a small piston to prepare it for the turning and grinding. The work is done by a boy on a drill press and by this method he is able to finish three in the same time that it formerly took a man to do one on a lathe. The machining consists of boring and facing one end of the piston approximately true with the inside as shown at *a* and *b*, Fig. 1.

The casting which is shown in Fig. 1 is placed in the jig, Fig. 7, but not at once clamped in place. The jig has been

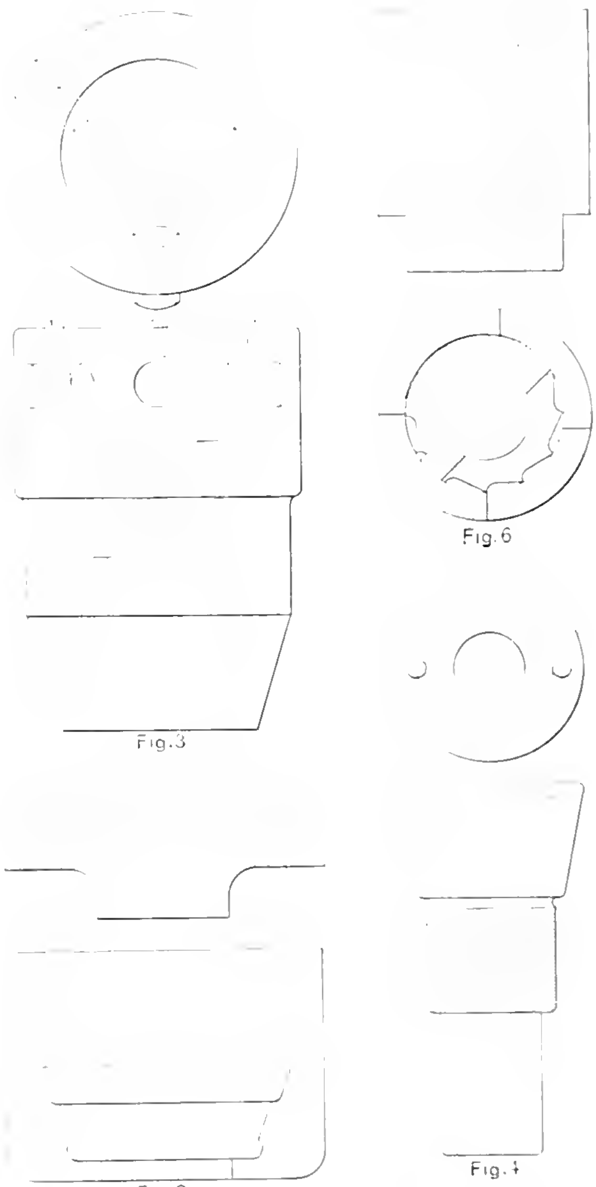


Fig. 6

Fig. 3

Fig. 2

Fig. 4

secured in place on the drill press, in spindle of which are held the boring and facing tools shown in Figs. 5 and 6. Two similar pieces, one of which is shown in Fig. 2, are then dropped to the bottom of the casting and followed by the part, Fig. 3, which, as it goes down, pushes the first two hard against the sides. The part shown in Fig. 4 is then screwed into place, the taper thereon forcing the sliding pins or dogs hard against the sides of the casting. The spindle of the drill press is now lowered until the pilot enters the lower bearing of the bushing, Fig. 4, after which the four setscrews in the sides of the jig, Fig. 7, are brought against the sides of the casting, and the clamp put in place and drawn up tight.

Before the roughing tool, Fig. 5, is placed in the drill press spindle, the finishing tool, Fig. 6, is slipped over its shank, with the lower end of the reamer resting on the roughing

cutters. After the roughing is done, Fig. 6 is turned around until the two slots come over the roughing cutters, when it will drop down until the finishing cutters are below. The taper pin is then put in place to hold it down when the finishing cut is taken.

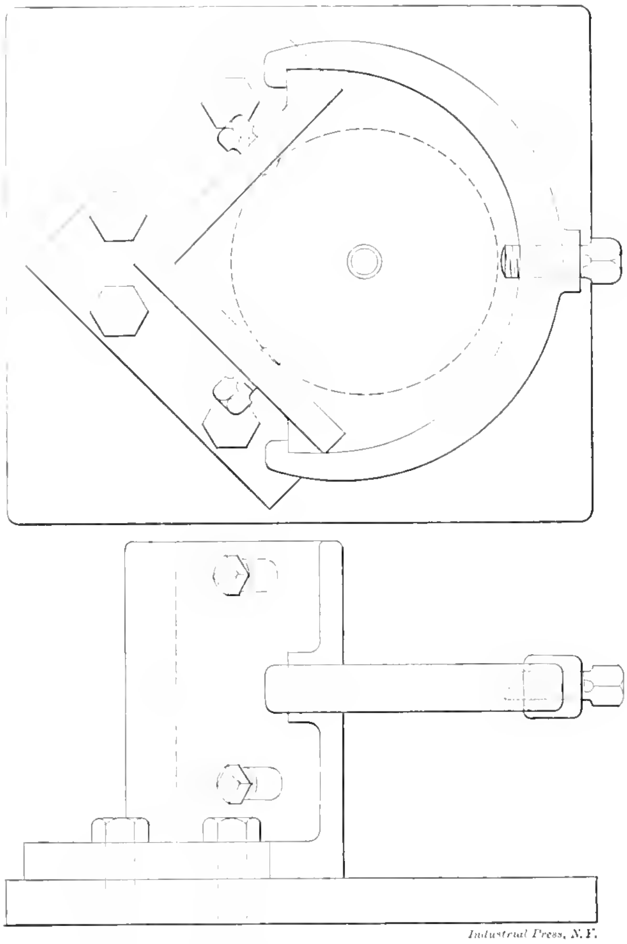


Fig. 7. Jig for Holding Cylinder.

After this operation the wrist pin hole is drilled in a jig, after which it goes to the lathe where it is drawn against a face plate by means of an eye bolt and pin, and is turned and ground in one setting. WILLIAM N. TAYLOR.

MAKING A CORE BOX FROM THE PATTERN.

Editor MACHINERY:

The following method of making a core box for a pattern, after the original core box had been destroyed, was used by

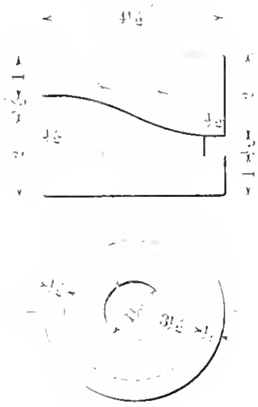


Fig. 1
Finished Casting

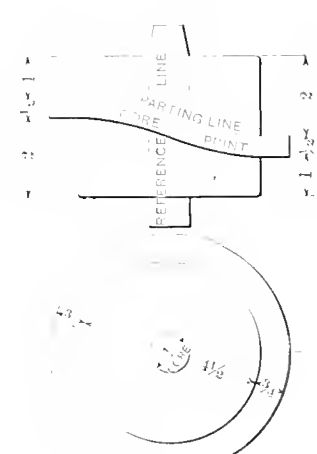


Fig. 2
Pattern with Core Prints

Making a Core-box from the Pattern.

us and may be of interest to some readers of MACHINERY. Fig. 1 shows the finished casting and Fig. 2 the pattern as sent to us. The pattern was parted, along the top of the core print, as shown in Fig. 2.

Three cylinders were turned up as follows: No. 1, Fig. 3, was made $2\frac{1}{2}$ inches long, hollow, with inside diameter of 6 inches, which was the outside diameter of the core print on pattern.

No. 2, Fig. 4, was made 2 inches long, hollow, with inside diameter of $3\frac{1}{2}$ inches, and outside diameter of 6 inches, which were, respectively, the inside and outside diameters of the core to be made:

No. 3, Fig. 5, was made solid, $2\frac{1}{2}$ inches long, with outside diameter of $3\frac{1}{2}$ inches. Reference lines were drawn on the pattern, parallel with axis, as shown in Fig. 2; on the inside of cylinder No. 1; on the outside of cylinder No. 3; and on both sides of cylinder No. 2.

The top of the pattern was taken off and the bottom part put inside cylinder No. 1, with reference line of pattern coinciding with reference line on inside of cylinder and highest part of pattern flush with top of cylinder. A line was then scribed along the inclined surface of pattern on the inside of cylinder, and the pattern was pushed back ½ inch (the thickness of core print) and with reference lines again coinciding, another line was drawn parallel to the first, and ½ inch below. The cylinder was now cut off along the first line drawn. Cylinder No. 2 was then put inside cylinder No. 1, with bottom of No. 2 ½ inch above bottom of No. 1, and with reference lines coinciding. A line was scribed along

Fig. 3 Cylinder No. 1.

Fig. 5 Cylinder No. 3.

Fig. 4 Cylinder No. 2.

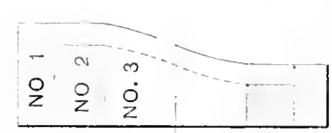


Fig. 6 Cylinder No's 1-2-3
Complete Core Box.
Machinery, N.Y.

Parts of the Core-box.

the inclined surface of cylinder No. 1, on outside surface of No. 2, and cylinder No. 2 was cut off to line scribed. Cylinder No. 3 was put inside No. 2, with bottom of No. 2 ½ inch above bottom of No. 3, and with reference lines coinciding. A line was scribed along inclined surface of cylinder No. 2 on outside surface of No. 3, and cylinder was cut off to this line.

Then cylinder No. 2 was fastened inside No. 1, and cylinder No. 3 was fastened inside of No. 2, with the bottom surfaces all flush, and all reference lines coinciding, this making the complete core box as shown in Fig. 6. Cylinder No. 3 should come flush on top with cylinder No. 1, and cylinder No. 2 should be ½ inch below, and should come even with the second line scribed on cylinder No. 1.

This method does away with making paper templets and obviates mistakes caused by discrepancy in transferring from paper to wood. If the curve is irregular it is just as easy to lay off with this method as if it were a regular curve. We get the exact curve because we scribe our first working line from the pattern itself. JULIAN D. PAGE.

Youngstown, Ohio.

* * *

"CAST IRON SINKS."

A good joke, like the Wandering Jew, can never die. Although it be as ancient and hoary-headed as the everlasting hills, still will it periodically come forth from some unknown hiding place, and gambol before the multitude as nimbly as when the world was young. Who in his youth has not heard of the rustic glaring at the sign: "Cast Iron Sinks" and his scornful comment: "Of course it does, who thought 'twould float," but, like Banquo's ghost, it again walks, and the printed page of a contemporary blazons it forth as a fine sample of original Maine humor to tickle the risibilities of the simple-minded.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

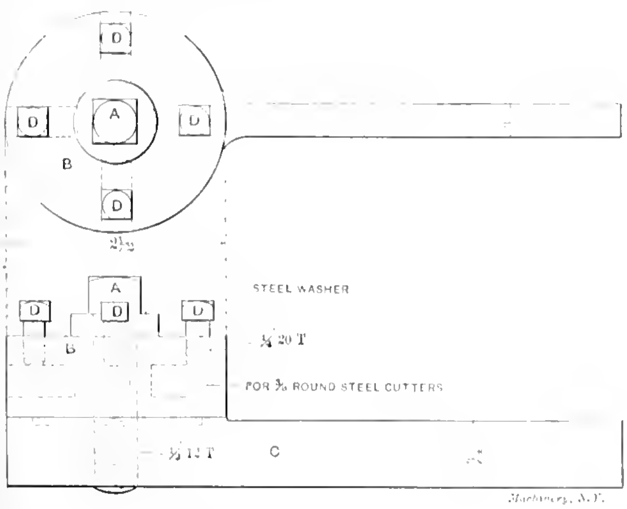
SCREW CUTTING KINK.

When cutting screws of very quick pitch, or cutting the teeth of spiral gears in a lathe, I place a pulley on the lead screw and lengthen the cone belt so as to drive the lead screw directly from the countershaft, and drive the spindle back through the change gear. By doing this, I am enabled to drive the carriage back and fouth much quicker and with less strain on the lathe. When cutting a quick pitch, more power is generally required to operate the carriage than to drive the spindle. EUGENE WORALETZKY.

Trenton, N. J.

TURRET TOOL HOLDER.

The sketch shows a turret toolholder that I use in the toolpost of an engine lathe, and which I find to be a great timesaver on many jobs. The lower or shank part of the tool *C* is a forging with an enlarged end, which is faced, recessed and tapped for the ½-inch clamping screw, *A*. The turret head *B* is turned with a shoulder to fit the recess in the shank *C*, and has four holes drilled in its periphery for the ⅝-inch Jessop steel cutters. The cutters are held with ¼-inch setscrews. On most work the turret head is set so that two tools are used without loosening the clamping screw, *A*, and in some cases three tools may be so used. For instance, suppose we have a facing and turning job on a ring that can



be caught on the outside of the chuck jaws. The right-hand tool is used for facing the side of the ring next the chuck; the front tool for turning the outside; and the left-hand tool for facing the side toward the tailstock. In close quarters, of course, this cannot be done, but where it is necessary to shift the turret it can be done much quicker and with a fraction of the effort required to change a tool held in the toolpost. While the turret has only four holes a mechanic with some ingenuity will often be able to perform five or six operations with them. A gear blank, for example, can be centered, drilled, bored and reamed (a shell reamer being fitted over the boring tool), faced and turned with it. In fact it makes a pretty fair substitute for a turret lathe on many jobs.

New York. L. S. ROSENTHAL.

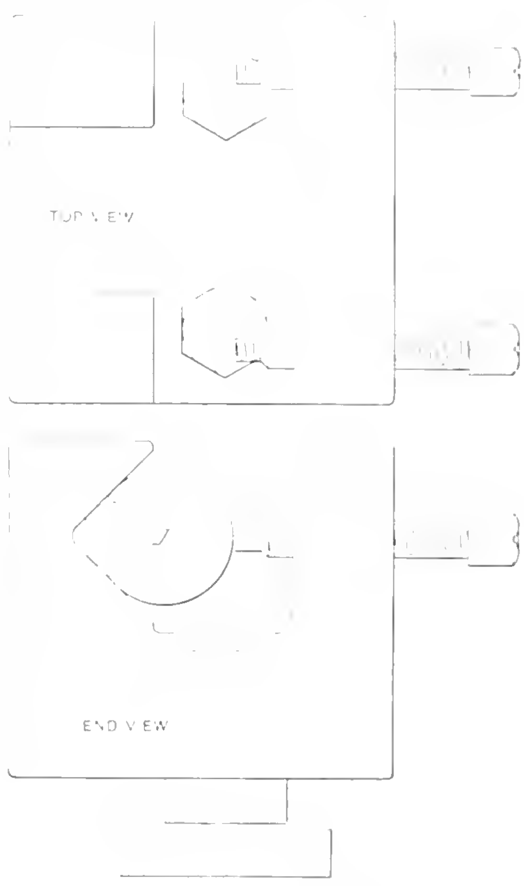
SHRINKING NUTS OR RINGS FOR PERMANENT SET.

If you should have a nut that requires a snug fit and the tap has cut it too large by three to five thousandths or more, put the nut in the fire, heat it to a bright cherry red, then hold it on a rod and let a stream of water strike it on the outside, keep it turning all the while, cooling off from the outside entirely. Another good way is to heat the nut, the same as before, then hang it on a hook of light wire and immerse one-half of it in the water until cool, then place it back in the fire, heat it as before and cool the other half in the same manner. Be sure to turn the nut half around. Often the nuts fit a little too tight after shrinking, but it is an easy matter to reduce the bolt a few thousandths. In shrinking a ring of about 8 inches diameter made of ⅜ x 1¼-inch flat stock, the diameter can be permanently reduced about ⅛ inch by heating to a glowing red and dipping in the water edgewise to just half the width until cool, then place in the fire, heat, as before, and cool the other half in the same manner. The idea is to shrink one edge and the other will be compressed as long as there is enough heat in it, and so takes a permanent set. C. D.

Hanover, Pa.

BORING BAR HOLDER.

The accompanying sketches illustrate a boring bar holder in use on a 24-inch lathe. It is made of soft steel, and was casehardened to keep the V-groove from getting bruised. It was made large enough to take in a 3-inch bar. In this holder the boring bars are always at the proper height regardless of their size. No extra bushings are required for smaller bars. A socket for a large size taper shank drill and the necessary reducers are part of the outfit.

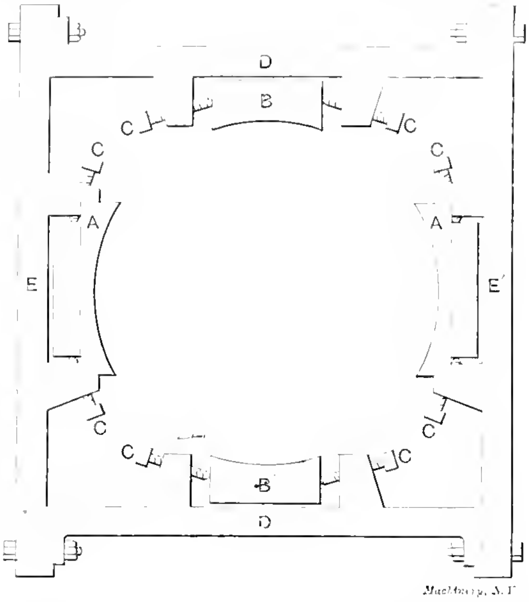


In making this holder the outside was finished, and also the inside, excepting the V. It was then put on the lathe and a light cut taken on both sides of the V, using a bar held in the chuck. Then the V was planed true with the cut, this insuring that the bar would always be held in line with the centers. H. G.

FIXTURE FOR BORING BRASSES.

The cut shows an efficient and cheaply made jig or fixture for holding the main brasses and quarter brasses of large bearings, for boring. The frame of the jig is composed of four parts, *D D'* and *E E'*, held together at the corners by through bolts. The height of the jig or fixture depends of course upon the length of the brasses to be bored. The reason for making the jig or fixture in four parts, as indicated, was first that the pattern work and molding was cheaper, and second that the jaws for the brasses could be easily planed out, which would not have been the case in this shop if cast solid, since we have no slotter. The plan of the jig is

shown in the cut, and it will be noted that the holding screws *C* are set in an inclined position, thus tending to force the brasses solidly against the outside of the fixture. It was

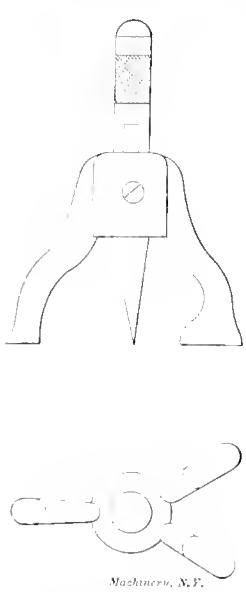


made so that it would take in a variety of sizes, distance pieces being provided to go between the brasses and the frame. It is used on a boring mill and works very well.

PHILADELPHIA.

PRICK PUNCH HOLDER.

The accompanying cut (which is full size) of a prick punch and holder was designed for prick-punching the center mark when laying out work that is afterward to be trued up by this center mark in the lathe by an indicator.



The punch is made an easy but close fit in the holder and is flattened slightly on one side as shown, so that the small setscrew will keep it from coming out of the holder. The point of the punch must be ground true after hardening, otherwise it might draw to one side when struck with the hammer. As the holder rests on three legs there is no tendency to rock, and when the point of the punch rests on the work and is given a light blow, it is sure to go straight down, leaving the center and sides of the hole true. When a center is required that comes close to the edge of the work the two legs with the largest feet may be pressed firmly down to the work and the third leg allowed to overhang while the blow is struck.

Watervliet, N. Y. M. H. BALL.

TOOLS FOR FACING WORK IN THE LATHE.

We all know what a useful tool the half center shown in Fig. 1 is, and we also know that it is a tool rarely found on the various lathes in machine shops, although it is a very annoying proposition to properly face off the ends of shafts, etc., without the proper tools. For this purpose I devised a little contrivance which is a "crackerjack." My first plan was to use the combination drill and countersink (60 degrees) for centering in the usual manner and then re-countersink slightly with a blunter countersink about 90 degrees. Fig. 2 shows how this second countersinking operation made it easy to face down the center. Fig. 3, however, shows my improved method of obtaining the desired result, the small shell end mill *A* being made of drill rod to fit the combination drill and countersink. The teeth are simply filed and headless screw is pointed and small notches are ground in the body of the countersink which completes the outfit. It will be found extremely useful, and especially desirable is the feature of using this new combination tool for the ends of mandrels, as it sets the center back from the end, thereby protecting same from the hammer blows. Various sizes of shell mills

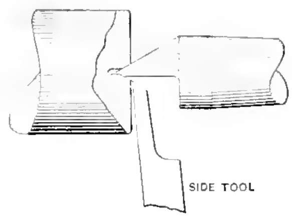


Fig. 1.

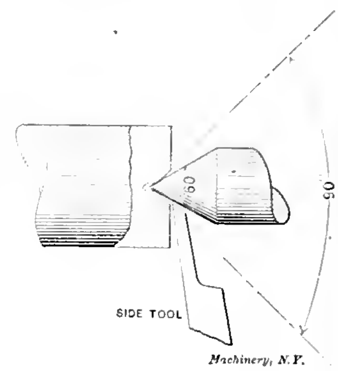


Fig. 2.

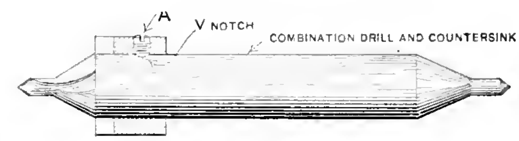


Fig. 3

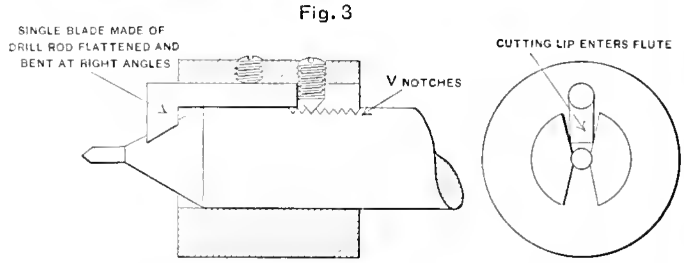


Fig. 4

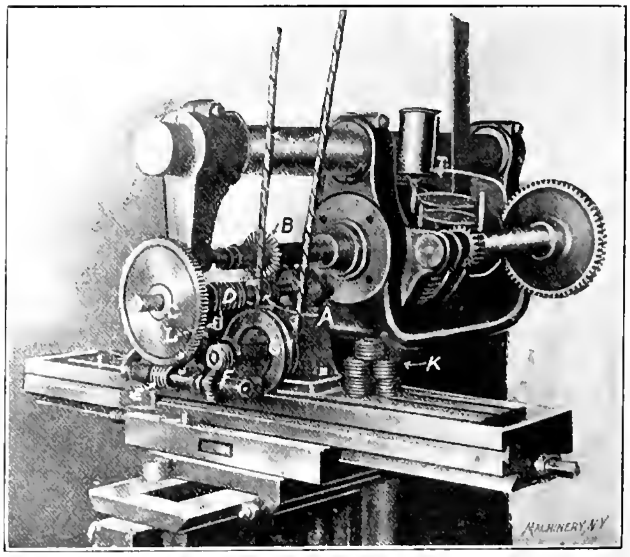
can be kept on hand should same be found necessary. Fig. 4 shows a single blade arrangement adjustable so small centers can be drilled.

ROBERT A. LACHMANN.

Chicago, Ill.

MILLING MACHINE ATTACHMENT FOR THREADING WORM WHEELS.

The half-tone shows a milling machine attachment used in our shop for several years for cutting the threads of cast iron worms. It includes a base which is bolted to the milling machine platen and provided with bearings for the work arbor and the cone pulley shaft. The worm to be cut is mounted on the arbor and is rotated and moved longitudinally at the same time so as to mill the thread. *A* is the work; *B*, the milling cutter; *C*, a worm wheel; *D*, the lead screw; *L*, a pin having a thin end, which engages the thread of lead screw and acts as a half-nut; *E*, a worm driving wormwheel *C*. It in turn receives its motion from the worm and wormwheel shown at *F*. Power is transmitted to the cone pulley *G*, by the leather belt *H*. The work arbor is splined and is free to



move longitudinally in its bearings, so that as it rotates the lead screw can move it longitudinally as is required to generate the thread. A number of the finished worms are shown on the platen at *K*. PHILADELPHIA.

USING A TAP AS A REAMER.

Having drilled a hole which I was intending to ream out with a 1¼ inch reamer, I found that there was not one of the reamers of that size could be used. So an old tap of the same size was fitted with an extension holder (so it could be held in the drill chuck) and put it in the drill press chuck. Putting on the feed I got as good a hole as I could have gotten with a regulation reamer. Of course the tap could go no faster than the feed was set and consequently the thread cut by one tooth was cut off by the next. ROBERT B. OTIS.

Orange, Mass.

PLANING A CROSS GROOVE.

On one occasion I had to plane a groove in a very large table square across the face. To drive the tool back and forth by hand with the cross-feed is a very tiresome job, so I rigged up means for doing it by power. We had two planers in the shop standing parallel to each other. From planer No. 1 I took out the cross-feed screw, and placed in the end bearing a roller over which a chain was run to a roller in the toolpost of No. 2, then connected to a heavy stud in the platen of planer No. 2. The other end of the chain was secued to the cross slide of planer No. 1 by one of the swiveling screws. Another chain was connected to the opposite side of the cross-slide and run over the roller held in the toolpost in planer No. 2, and thence to the heavy stud. One chain was used to pull the cross-slide back, and the other to pull it ahead. The stroke of the platen of planer No. 2 was set at just the right length, and a helper stopped it at the end of each stroke and exchanged the chains, while I operated the feed on planer No. 1. It was necessary to lift the tool up on every back stroke, as the clapper-box, of course, could not lift to relieve the tool. EUGENE WOPALETZKY.

Trenton, N. J.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

12. C. W. M.—In the directions for turning tapers in the September, 1904, issue, where does "J. T." get the figure 8 which he uses as a multiplier of the distance between the centers; also of the distance to throw the tailstock?

A.—The use of the number 8 as a multiplier is optional, any number could be used instead—or none. The idea is merely to increase the length and amount of taper for convenience in measurement. But both the length and the taper must be multiplied by the same number in order to keep the correct proportion. With the larger dimensions, it is, of course, much easier to get accurate measurements, and that is the only reason for multiplying the given dimensions by *any* number.

13. H. T. S.—I made the lathe roller according to the instructions given by Mr. R. F. Kiefer in the August issue, but find that it works unsatisfactorily. When forced against the work under sufficient pressure to smooth it, the roller ceases revolving and stops. What is the trouble?

A.—The reason the roller refuses to revolve when forced against the work with considerable pressure is undoubtedly because of excessive friction in the bearing. It may be that you did not get the hole through the fork bored square with the sides, in which case the roller may bear hard against one side. In any case the roller should be made with narrow collars projecting above its sides immediately around the bearing. These collars take the side thrust against the sides of the fork and thus reduce the friction from what it would be if the whole side of the roller bore against the fork. To further reduce friction the bolt or pin upon which the roller revolves should be hardened; this also prevents cutting. In general it is best to make lathe rollers for finishing work with a wider bearing than that indicated in Mr. Kiefer's sketch. The best practice is to make the bearing from two to three times the width of the face, thus with a ½-inch face the bearing should be, say 1½ inches long. In some cases the roll is made of brass or bronze, thus reducing the frictional resistance.

14. Y. E. B.—Will you please explain the method of determining the compression space in a gas engine cylinder so as to obtain any desired amount of compression?

A.—There are two parts to the inside of a gas engine cylinder, one being the compression space and the other the portion traversed by the piston. The latter is equal to the stroke in length, so we will designate it by the term "stroke," while the former we will call the "compression." The sum of these two portions is equal to cylinder volume. See Fig. 1.

Now, if we desire to make our calculations in atmospheres, then the number of atmospheres which we wish the compression to be will represent the total cylinder volume, and one atmosphere will represent the compression space, so we have: Total cylinder volume — 1 = stroke. See Fig. 2.

If we wish to build an engine having a stroke of 12 inches with a compression equal to 4 atmospheres, we would have: Cylinder volume, 4 — 1 (compression) = 3 = stroke. The stroke is 12 inches, so if 3 equals 12 inches, then 1 equals 1-3 of 12, which is 4 inches. Therefore, the compression space should be 4 inches in length.

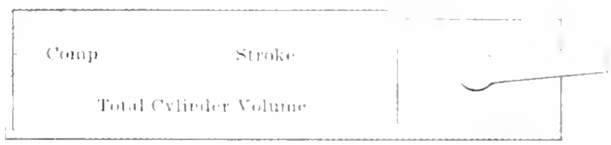


Fig. 1

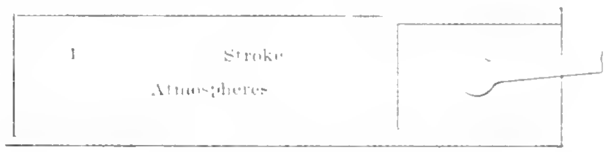


Fig. 2

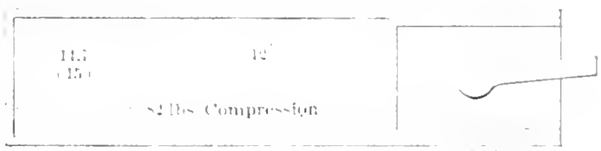


Fig. 3

Had we desired to obtain a compression of 4⅛ atmospheres, then 4⅛ = 33-8, so that 33 = cylinder volume and 8 = compression. Then 33 — 8 = 25 = stroke. If the stroke is 12 inches, 8-25 of 12 = 3.81 = compression space. This relation may be expressed by the formula:

$$\frac{\text{stroke}}{\text{atmospheres} - 1} = \text{compression space.}$$

If it is desired to express the compression in pounds rather than atmospheres, then the compression space will be represented by the value of 1 atmosphere in pounds, or 14.7 pounds. The total cylinder volume or length will be represented by the total number of pounds compression to be obtained. In this case we have:

$$\frac{\text{stroke} \times 14.7}{\text{compression} - 14.7} = \text{compression space. See Fig. 3.}$$

For general purposes, it is sufficiently accurate to consider the value of 1 atmosphere as 15 pounds.

Example: In an engine of 12 inches stroke, it is desired to have a compression of 82 pounds, what will be the length of the compression space?

$$\frac{\text{(stroke) 12-inch} \times 15}{\text{(comp.) 82 lbs.} - 15} = 2.68 \text{ inches} = \text{compression space.}$$

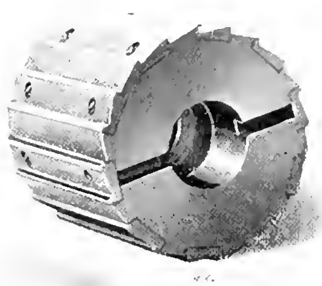
In the foregoing examples, no consideration has been taken of the increase of temperature.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

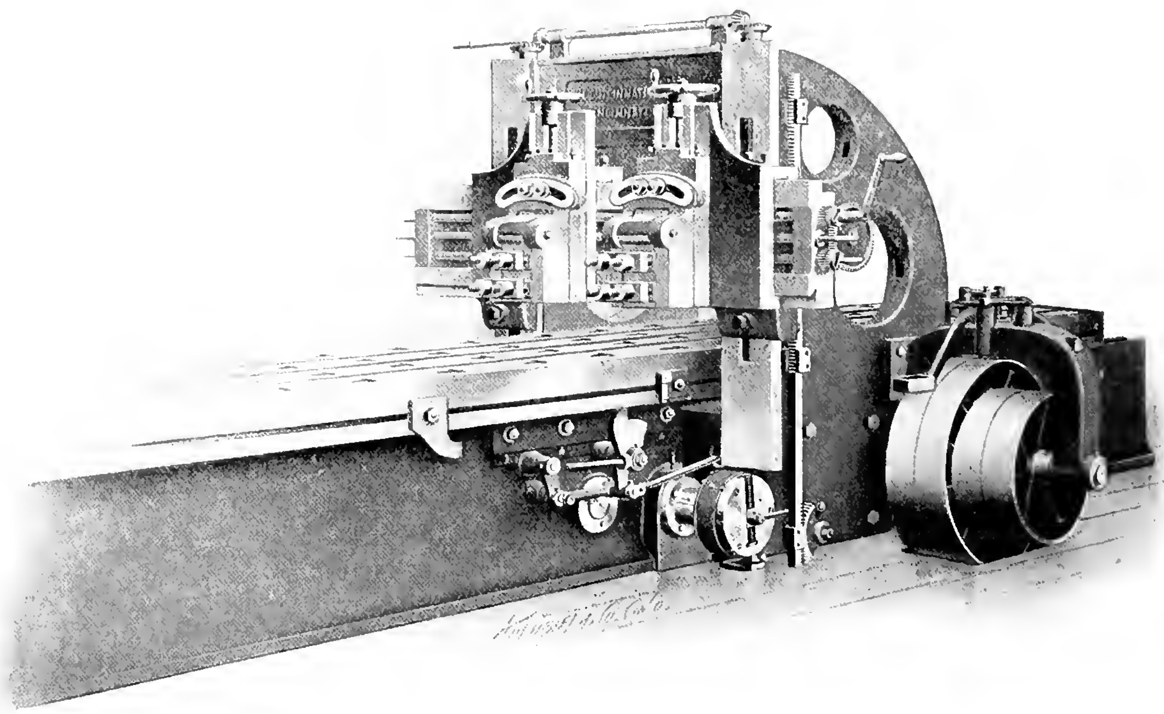
A "SOLID" ADJUSTABLE REAMER.

One of the late additions to the ever-increasing list of improved tools, and one that has the advantage of having been designed to meet the want which was felt for it in the shop



Gisholt Adjustable Reamer.

of its builders, the Gisholt Machine Co., is shown in the accompanying illustration. It is an adjustable shell reamer, the principal feature being the extra heavy blades, each having two cutting edges. This gives a simple and strong construction and is a close approach to the solidity of a one-piece tool. The body is made of crucible cast steel, bored and slotted to fit the standard shell reamer arbors. These reamers are manufactured in all standard sizes, both for hand and machine use.



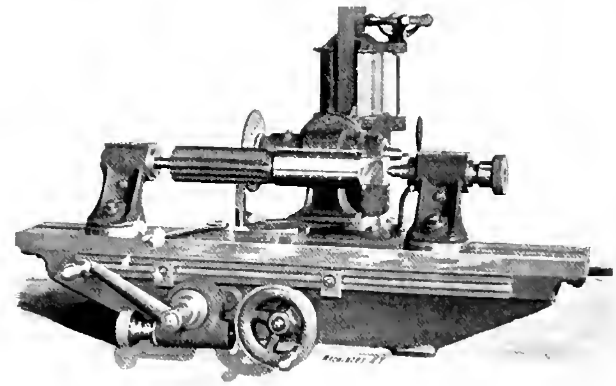
Planer for Frog and Switch Work, Cincinnati Planer Company.

THIRTY-SIX INCH FROG AND SWITCH PLANER.

The half-tone above illustrates a 36-inch planer for frog and switch work. In this tool the bed is deep and braced by box girders and four walls have been built between the housings, where there is the greatest strain. Extra wide vees are also provided, which are well lubricated. The table is massive and has an inside bearing on the bed its entire length, overcoming the pressure of heavy side cuts; and to prevent lifting there are adjustable steel gibs on each side. The housings are of box form 10 inches face and extend to the floor. The cross rail is 18 inches wide and strongly braced, making a very rigid construction. The heads have automatic cross and vertical feeds, and are made right and left to bring them close together. There is a safety locking device on the shifting mechanism, and the levers are so arranged that the machine can be operated from either side. The driving shafts are unusually large and run in long bearings fitted solidly into the bed. The rack and gearing are made from solid crucible steel and have been designed to withstand the enormous strain incident to frog and switch work. The countershaft gives two cutting speeds, with a constant return, and is equipped with adjustable ring-oiling hangers. This tool is manufactured by the Cincinnati Planer Co., Cincinnati, O.

WALKER TOOL GRINDER.

We recently illustrated a new cutter and reamer grinder made by the Walker Grinder Co., Worcester, Mass., which has a number of novel features. Among these is the swiveling head attached to an upright column at the rear of the machine, the construction being made possible by the method of belt connection in the Walker type of grinder. The swiveling head construction and belt connection are employed also in the grinder shown herewith. The machine, however, is smaller and less expensive than the one previously illustrated. It is made either as a bench grinder or is mounted on a base, as preferred. The spindle can be used at any angle from horizontal to vertical without altering the belt tension, adapting it to grinding angular mills, backing off reamers, grinding shoulders, the edges of flat pieces, etc. The machine is pro-



Walker Tool Grinder.

vided with an adjustable stop for lever cross feed, the bed is supported on a three-point bearing, the platen is of the T-slot pattern and the center heads are clamped against one side of the T-slot insuring perfect and permanent alignment. All swiveling parts are graduated. An overhanging guard on the rear protects the cross slide. A graduated swivel socket holder, which can also be used as a center, and a tail center block, are provided and, if desired, a vise and other accessories can be supplied.

NEW SENSITIVE DRILL PRESSES.

There has recently been perfected a sensitive drill press for which many advantages are claimed. The inventor of this machine is Mr. Charles D. Rice, superintendent of the

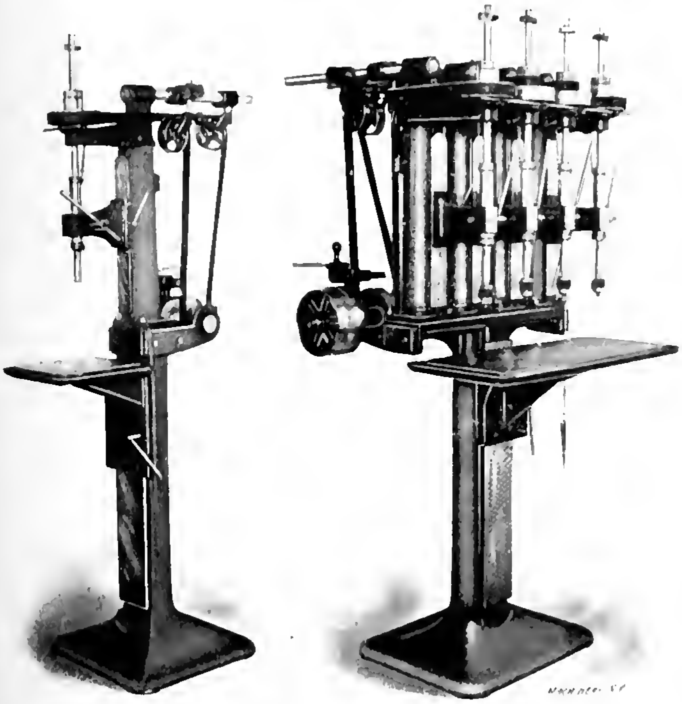


Fig. 1. Drill Presses made by the Henry & Wright Mfg. Co.

Underwood Typewriter Co., Hartford, Conn. Mr. Rice's extended experience in the manufacture of small parts led him to believe that marked improvements were possible with light drilling machines, particularly as regards the high spindle speeds for small drills and the driving efficiency for large ones. This new press is manufactured by the Henry & Wright Mfg. Co., of Hartford, Conn., which company has had designed and constructed a complete outfit of special tools and fixtures for its manufacture in quantity lots and on a strictly interchangeable basis, they having acquired the exclusive right to manufacture for the American trade.

In this drill press the friction is very largely reduced by the use of ball bearings throughout. The spindle is driven by a continuous cemented belt, with means for taking up any slackness and for giving the belt sufficient tension. A new balanced roller key for the spindle drive reduces the friction required in feeding the drill spindle under heavy orsional strains; and the frame is heavier than usual, to secure rigidity. There is also an arrangement whereby four spindle speeds are obtained without adding to the weight of the pulleys. These features have resulted in a greater increase in the amount of work turned out.

Recent tests have shown the following results: A 5-16 drill driven at 1,740 revolutions per minute, drilled through cast iron 1¼ inches thick in 5 seconds, which in one minute would drill through cast iron 15 inches thick. A 7-16 inch drill driven at 780 revolutions per minute, drilled through cast iron 1¼ inches thick in 7 seconds, which in one minute at this speed would drill through cast iron 10 inches thick. A ¾-inch drill at 780 revolutions per minute, drilled through cast iron 1¼ inches thick in 15 seconds, which in one minute at this speed would drill through cast iron 5 inches thick.

These are so unusual that they would seem to a mechanic to be exaggerated, but we are assured that they are actual results that can easily be attained by one of these machines.

It will be observed that the adaptability of the press to drills of from ⅜- to ¾-inch diameter, which heretofore sensitive drill presses have not been able to handle with the economy of heavier machines, makes it available for much of the drilling that has heretofore been done on slower upright geared drill presses.

As stated, the drill presses are equipped throughout with ball bearings, even to the loose pulley used for its driving belt; and the machines run so freely that the same width of belt and size of main driving pulley are used for any number of spindles, from 1 to 6. The same width of belt is used for the main drive as on each drill spindle. The rated power of the driving belt, as given by the makers, for a 6-spindle machine, is but 30 per cent. of that commonly used, yet they state that the drill spindles have fully twice the driving capacity of a machine without the ball bearings, and other features for increasing the efficiency.

Fig. 2 shows details of the driving shaft at the rear of the drill press and indicates the character of the ball bearings on both pulleys and also the method of adjusting the driving pulley on its shaft to enable it to track properly when the belt is changed from one step of the pulley to the other.

A novel idler system has been introduced to make the single endless belt feature feasible. The innermost idler can be adjusted vertically to deliver the belt to either step of the drill spindle cone, while the rear idler has a horizontal adjustment for giving the belt any desired tension.

An interesting feature is the method employed for obtaining four different speeds for the drill spindles and with but two steps to each cone pulley. The plan is to procure the two slowest speeds by allowing the belt to remain on the largest drill spindle pulley step and to shift the rear driving cone pulley lengthwise, introducing either step of the rear driving pulley for action. The two higher speeds are had by dealing with the small step of the drill spindle pulley in a similar manner. It will be noted that when the larger drills are in use only the major diameter of the spindle pulley is used, thereby giving marked driving advantages; also when dealing with smaller drills and which offer less resistance, a very much smaller pulley diameter is used, thereby maintaining a low belt travel as compared with the drill spindle speed, so that

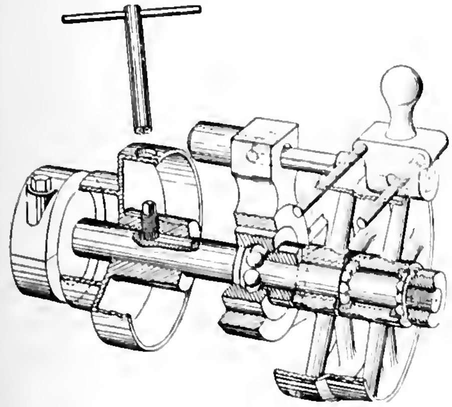


Fig. 2.

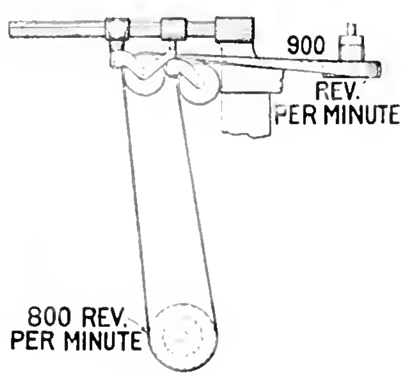


Fig. 3.

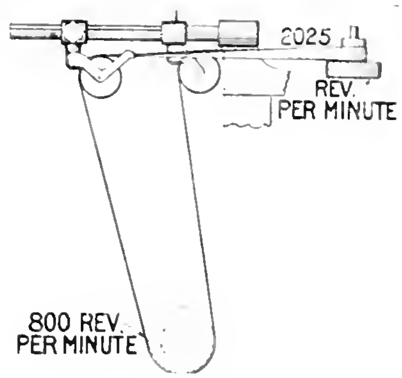


Fig. 4.

with the belt travel advantage, and frictionless journals, very high speeds are possible in every-day practice, which particularly qualifies the tool for the using of drills made of high-speed steel.

In Figs. 3 and 4 the belt is shown in two different positions, for giving spindle speeds respectively of 900 and 2,025 revolutions per minute, with a constant speed of the driving shaft of 800 revolutions per minute. In Fig. 3 the belt is on the large step of the driving pulley and the large step of the spindle pulley, with the idlers arranged accordingly; while in Fig. 4 the belt is still on the large step of the driving pulley but on the small step of the spindle pulley. Similarly by changing to the small step of the driving pulley, two more speeds of 900 and 1,350 revolutions per minute are obtained without changing the speed of the driving shaft. In the large sketch Fig. 5 is a rear view of the machine indicating the method

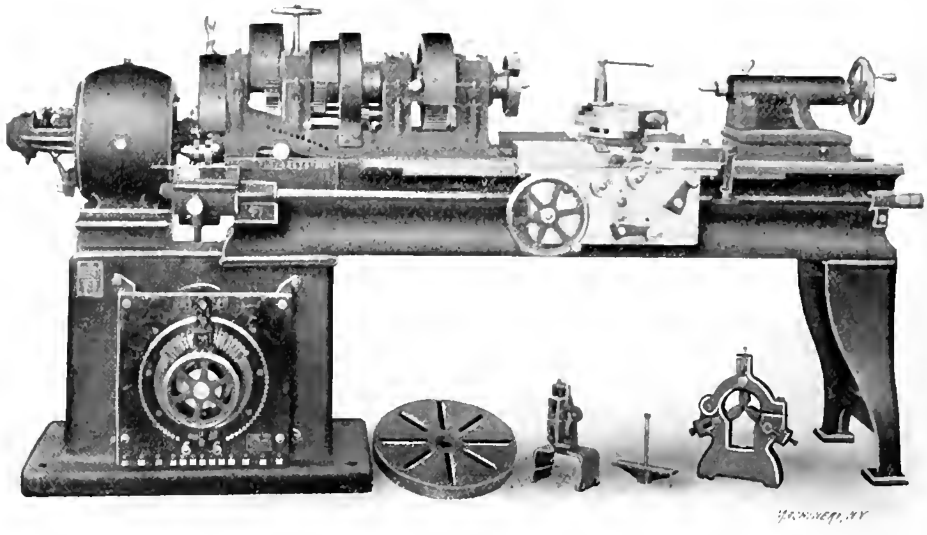


Fig. 1. Lathe Designed especially for Motor Driving.

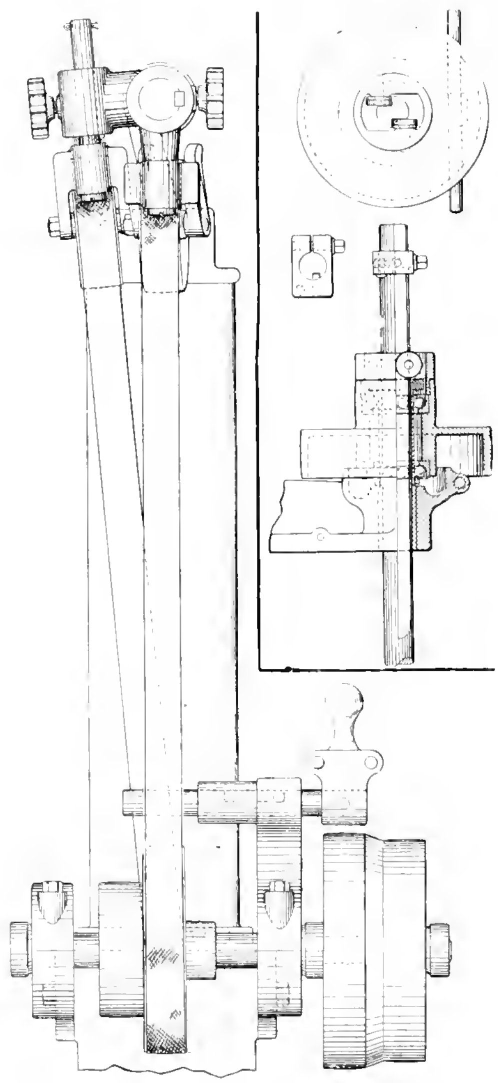


Fig. 5.

of adjusting the idler pulleys to allow the belt to track properly and to take up the slack in the belt.

Another original feature is the use of balanced roller keys, placed diametrally opposite on the drill spindle, for transmitting power between the pulley and the spindle. The object is to overcome the drag due to a plain sliding feather. By using the two balanced keys the spindle is relieved of side thrust in the bearing which supports it within the pulley and by using keys of the roller type, which Mr. Rice has introduced, friction is further eliminated. The small view in Fig. 5 illustrates the balanced roller keys, to take up friction at this point, and also shows the detail of the two-step pulley which drives the spindle. This pulley runs on ball bearings on a sleeve attached to the frame of the drill press, which relieves the spindle entirely from strain due to belt pull.

These drill presses can be used with high-speed steel drills up to the full capacity of the drills, without injury to the press.

LODGE & SHIPLEY LATHE, WITH MOTOR.

The two illustrations herewith are of a motor-driven lathe as now built and equipped by the Lodge & Shipley Machine Tool Co., Cincinnati, O. The motor will give a speed variation of two to one, and the lathe head gives three speed changes which, with the two mechanical changes on the driving shaft, makes six changes obtained in the lathe itself. This

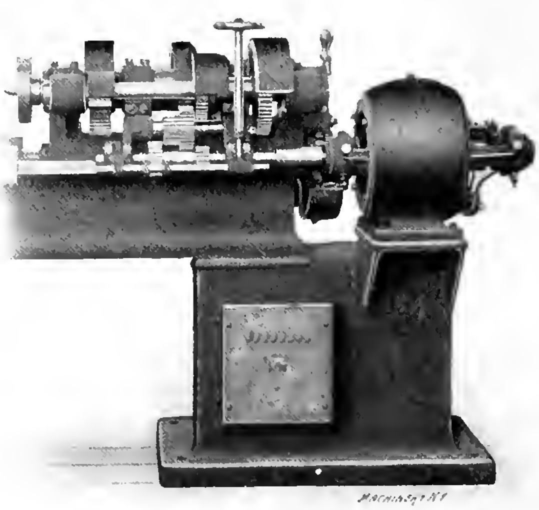


Fig. 2. Rear View of Headstock End.

with the speed variation of the motor, gives a very wide range. The whole arrangement is extremely simple and convenient for the operator. As regularly made, the controller is operated from the carriage and not as shown in the engraving. If desired the lathe can be furnished with a pulley suitably supported in place of the motor, so that the lathe may be operated directly from the line shaft with six changes of spindle speed. The special features to which the builders call attention are the mechanical simplicity of the design and its neatness of appearance. The headstock has all the advantages of the lathe head recently patented by this company, by which high speeds and heavy cuts are easily obtained throughout the whole range of diameters that the lathe can turn without introducing excessive strains or speeds in the bearings or other parts of the headstock mechanism. The illustrations shown in this connection are self-explanatory and need no further description.

NEW AUTOMATIC DRILLING MACHINE.

A year ago we illustrated a rotary-pattern multiple-spindle drill made by the National Automatic Tool Co., Dayton, O., for drilling the small parts of machinery to be manufactured in large quantities. This machine was designed with two groups of spindles, the idea being that if one set of drills was able to handle the drilling, the other set could be used for reaming or tapping; or if the holes were so near together, or there were so many of them that one cluster of spindles could not drill them all, the other group could be called into requisition. Another machine has now been brought out by this company in which this idea is extended so as to include a greater number of combinations, and perform a greater variety of work. The machine has a platen that revolves and carries the jigs with it. The pieces of work are put into and taken out of the jigs by the operator as the table rotates, and one complete rotation of the table completes all the operations to be performed upon a given piece.

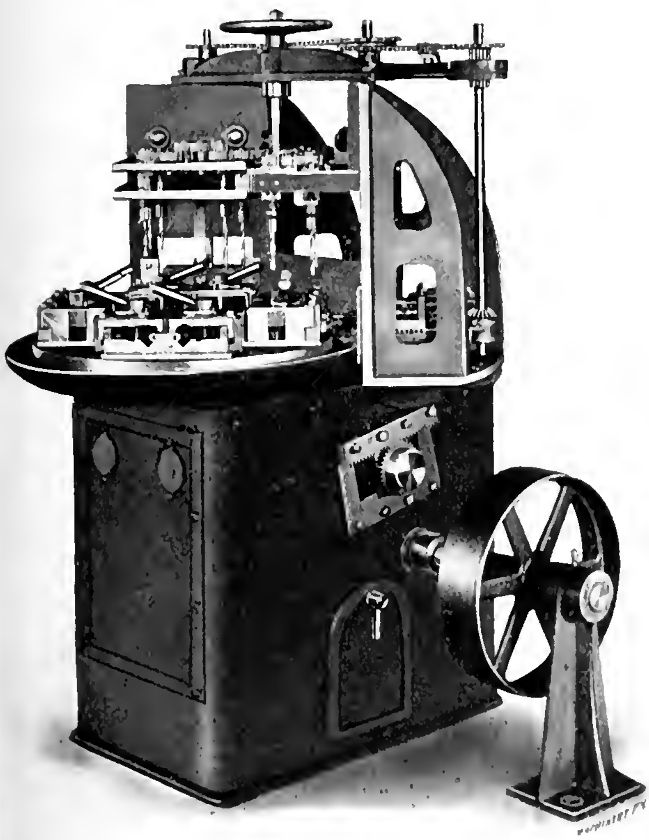


Fig. 1. Automatic Manufacturing Drilling Machine.

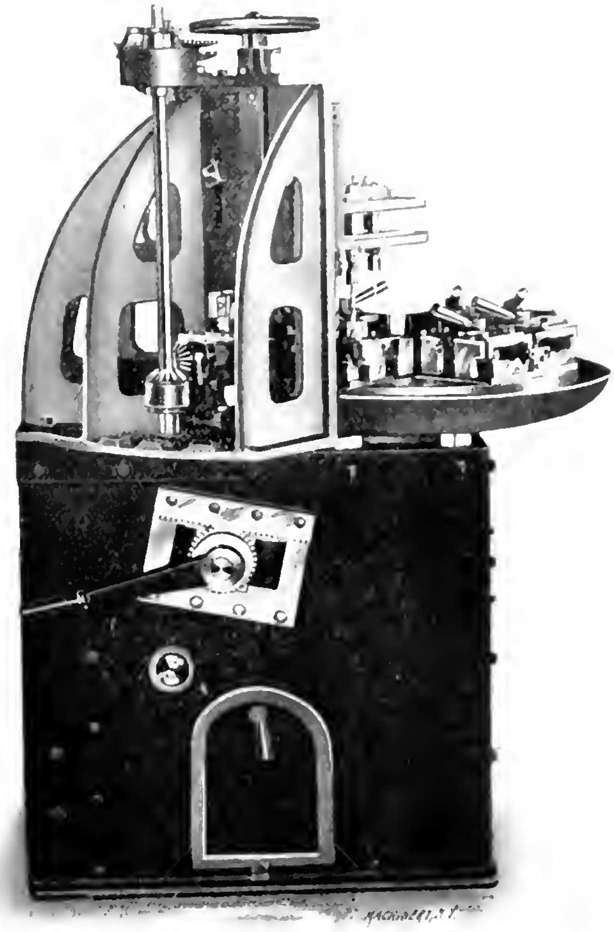


Fig. 2. Automatic Drilling Machine.

The machine has two vertical heads that are adjustable to give variation of depth in the hole drilled. The jigs are attached to the table with a key and dowel so that they can be easily removed and others substituted. The table can be indexed as many times per revolution as the character of the work requires. Among recent orders for this machine were two from a typewriter manufacturer who wished to use it in drilling small drop forgings. Each forging has two drilled holes—one to be reamed and one countersunk. The machine finishes 2,000 of these holes per hour. The jigs furnished for this particular job automatically open and close so that the only duty of the operator is to place the pieces to be drilled in position and remove them.

INTERESTING WORK OF A CIRCULAR SAW.

The universal saw table built by the Colburn Machine Tool Co., Franklin, Pa., of which we have already published a description, apparently has unusual capabilities in the hands of a competent workman, as shown by the samples of work illustrated herewith. This saw bench has all the adjustments of the table and guides that can be applied to such a machine, which enables angular and even circular work to be done to great advantage.

In Figs. 1 and 2 herewith are shown four sample boards of pieces all made on the Colburn saw, and are selected from a lot of six similar boards gotten out for the benefit of the agents of this company.

These samples show in a practical manner the great variety of work which can be done on this machine. No attempt has

Fig 1 Samples of Work done on Circular Saw

been made to put a fine finish on the samples, and they are shown just as the saws left them, and in most cases the saw marks are plainly visible. The object in leaving the samples in this manner is to prove beyond any question that they were

actually made with the circular saws, notwithstanding the seeming impossibility of such a performance. While it is true that some of the samples may be curiosities, still nearly all of them represent practical operations and to an ingenious mind suggest innumerable other cuts, all of which can be made on the machine.

Panels Nos. 1 and 2 show a variety of novel and fancy ornaments executed by the saw, which will suggest innumerable possible operations to the ingenious mechanic. Panel 3

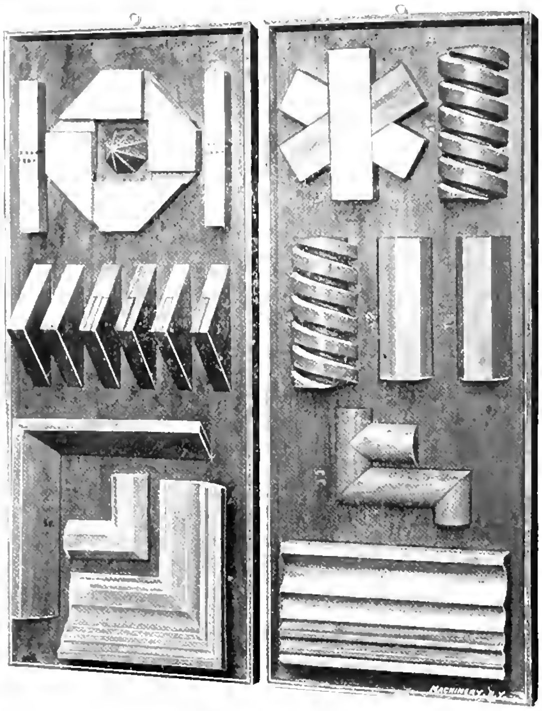


Fig. 2. Samples of Work done by Circular Saw.

shows samples of moldings having a variety of peculiar cuts, and in the center are six different samples of corner joints. Panel 4 shows, at the bottom, hollow cuts for such work as core boxes, etc., which may be made in sizes up to 4 and 5 inches in diameter. The next piece above illustrates special angular cuts made with the cross-cut saw. Above this are samples of polygonal shapes and samples of jointings; also a wooden screw made for a pattern. A larger illustration of this

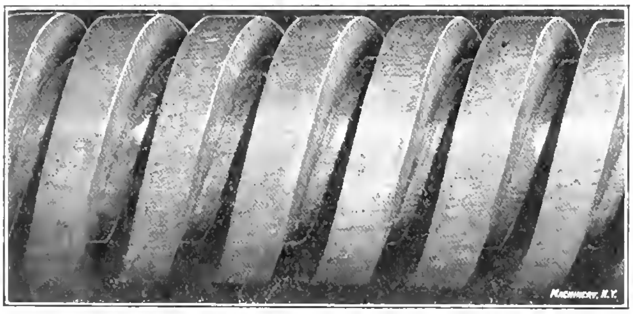
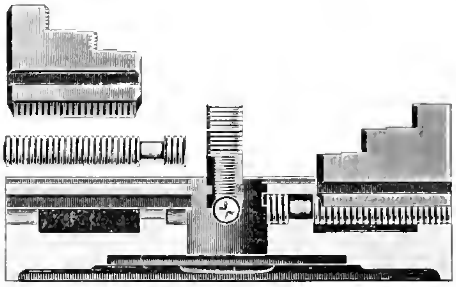


Fig. 3. Pattern for Screw Cut by Circular Saw.

screw appears in Fig. 3. This is made by first marking the lead of thread on a round cylinder. The table of the machine is tilted to the proper angle on the thread, and the saw adjusted to cut the depth of thread. The block is then revolved by hand and a little pointer assists the operator in following the markings on the outside. Screws of any diameter and pitch can be cut in this manner.

NEW SKINNER CHUCK.

A new 1904 pattern independent lathe chuck has been brought out by the Skinner Chuck Co., New Britain, Conn., which has several features of interest. The adjusting screws of the jaws are threaded to the periphery of the chuck body so as to permit the holding with safety of larger pieces in a chuck of the corresponding size than in others where the screw is only threaded part of the length and the thrust of the screw taken on the shoulder near the outside of the chuck. The screw has a square hole in the end for receiving a square headed wrench instead of having a square headed screw with the usual style of socket wrench; the advantage of this construction is that the operator can see just how to hold the wrench to enter the socket in the screw, while with the old style socket wrench the nut of the screw is covered and it is always a matter of guess work just how to turn the wrench to have it fit the nut. By taking the thrust on the screw near the inner end of the screw, this strain is brought directly under the face plate to which the screw is attached and is in the

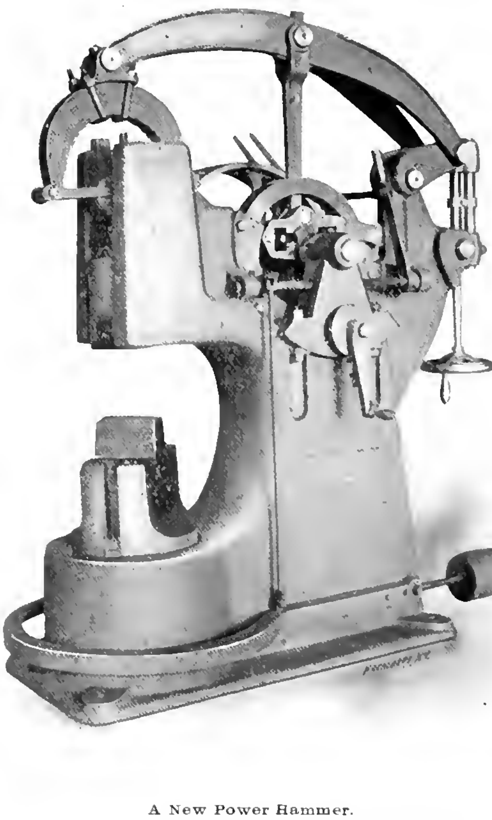


Details of Skinner Chuck.

strongest part of the chuck body. The jaws, which are made of drop forged steel and case hardened in this chuck, are ground on the steps after hardening, insuring the steps being parallel with the face of the chuck. It has been the ordinary practice to grind universal and combination lathe chuck jaws for a long time, but it is a new practice to grind the steps of the jaws on an independent jaw chuck.

THE "THOR" POWER HAMMER.

This hammer is composed as usual of a frame, an anvil, a hammer head, a lever, to which the hammer head is attached by means of the spring, and a crankshaft, acting on the lever. In the plane of the lever, there is supported in the frame, a ring of comparatively large diameter, through which the



A New Power Hammer.

crankshaft passes. To the ring is jointed an arm, which is connected to the crank of the shaft by being provided with a slot, in which it reciprocates during the rotation of the crank. There is a journal or sliding block on the crank. The arm is oscillated by this movement and is connected to the lever by means of links.

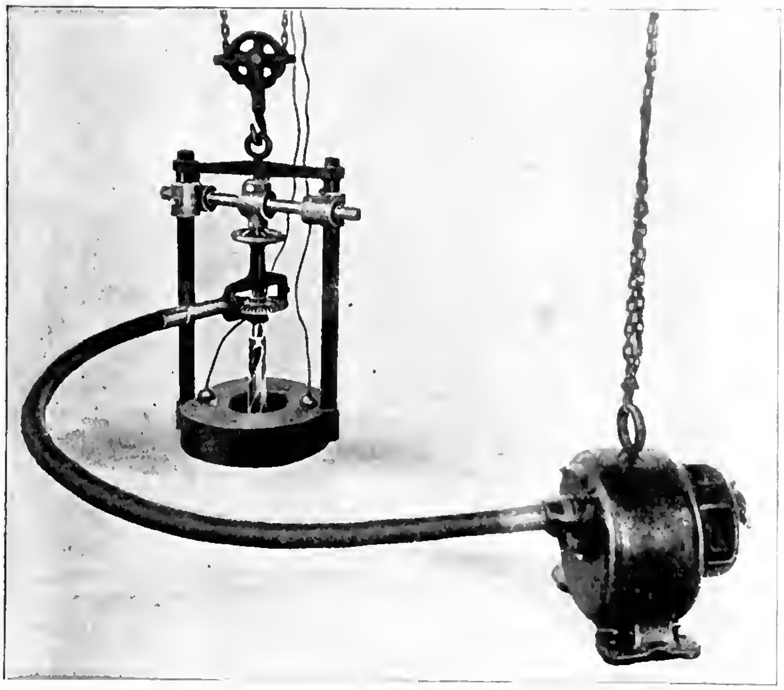
The length of the stroke is adjusted by revolving the ring. If the ring be rotated toward the right, the angle formed between the arm and the perpendicular through the shaft will be decreased. The stroke of the arm and consequently that of the lever and the hammer head, will thus be smaller. When rotating the ring toward the left, the angle mentioned will increase and the stroke of the arm and hammer head will be greater. The ring is rotated by means of the handwheel and screw at the rear.

The advantage of this construction is that the hammer ascends slowly and descends quickly, as the crank at the rotation of the shaft acts on the outer part of the arm when the hammer head ascends, but on the inner part of the arm when the hammer head descends.

It will be evident from the description that this construction gives a means for varying the strength of the blow, and also for adjusting the hammer for different sizes of forgings, while the hammer is running at full power; and these adjustments can be made without danger to the workman. The hammer is therefore applicable for large as well as for small work, and may also be used for drop forging. It is compact and easy to handle. The hammer is made in two sizes, one of which has a weight of drop of 170 pounds and one of 95 pounds. The former will operate successfully upon forgings 6 inches square, and the latter 4 inches square if occasion requires, but for general work the large hammer is recommended for forgings up to 4 inches square and the smaller one up to 3 inches square. The horse power required for the two hammers respectively is 4 and 1.5. The hammer has recently been brought out by the American Machine & Mfg. Co., Cleveland, O.

NOVEL PORTABLE EQUIPMENT.

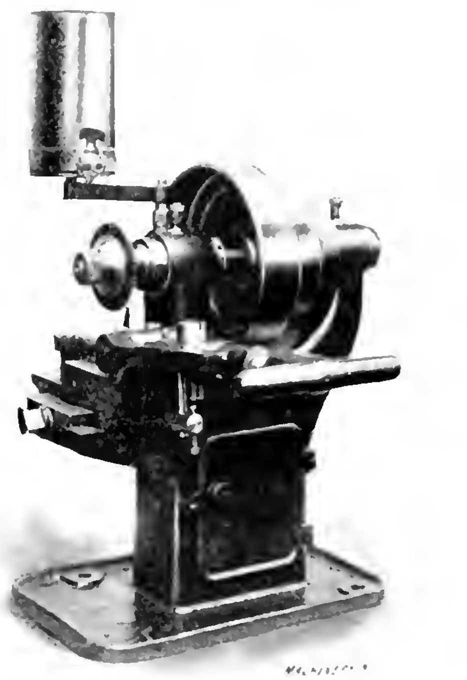
A neat portable drilling equipment has been brought out by the Coates Clipper Mfg. Co., Worcester, Mass. In this the drill is operated by electric motor through the flexible shaft manufactured by this company, but in addition to the general convenience of a portable drilling device of this description, this tool has the additional one of a magnetic hold-on arrangement which avoids clamping the "old man" to the material to be drilled. This hold-on is built strong enough for drilling a 2-inch hole, and is of especial value to steel plate and armor plate manufacturers. Formerly it was necessary to drill through a hole in the plate in order to fasten the bracket that holds the drill press, or else have the drill press backed up by a sufficient weight to take the thrust of the drill. The magnets used can be quickly attached or detached from the steel plate or casting by simply turning on or off the electric current, and in many classes of work the hole would be drilled while preparations were being made to attach the drilling device.



Drilling Device with Magnetic Hold-on.

BENCH SCREW SLOTTER.

The bench screw slotter illustrated herewith has been brought out by the Grant Mfg. & Machine Co., Bridgeport, Conn. In its design the manufacturers have aimed to meet the requirements of the shop having numerous small quantities of special screws, etc., to slot, and its capacity covers a range of screw sizes from the smallest to ½ inch filister head. The smaller ones can be slotted at the rate of 500 per hour. The spindle runs in two tapered self-oiling bronze bearings with adjustments on each to compensate for wear. The carrier slide has a transverse adjustment of ⅞ inch, making it possible to place two cutters on the spindle for milling two sides of a piece at once. The cone pulley has three steps for one-inch belt, and gives ample range of speed for both brass and iron screws. The jaws for holding the work are of one-inch round cold-drawn steel, and are simple and inexpensive to make. Jaws for irregular shapes that may be included in a ½- x ¾-inch space may be used in the machine to advantage. The fulcrum pin on which the carrier holding the jaws swings has large adjustable bearings, and the handle on the jaw clamping screw can be placed in such a position that when the jaws are closed this handle will be parallel with the spindle, the most favorable position for the operator. A stop screw is provided to regulate the depth of slots in screws. The method of operation is simple and rapid. The gripping, slotting, and releasing of the screws are all done with the right hand. The screw to be slotted is inserted between the carrier jaw with the thumb and finger of the right hand and is clamped with the screw shown at the top of the hinged carrier in front of the saw. After slotting the screw, the operator swings the carrier away from the saw, and at the same time releases it by a slight turn of the clamping screw

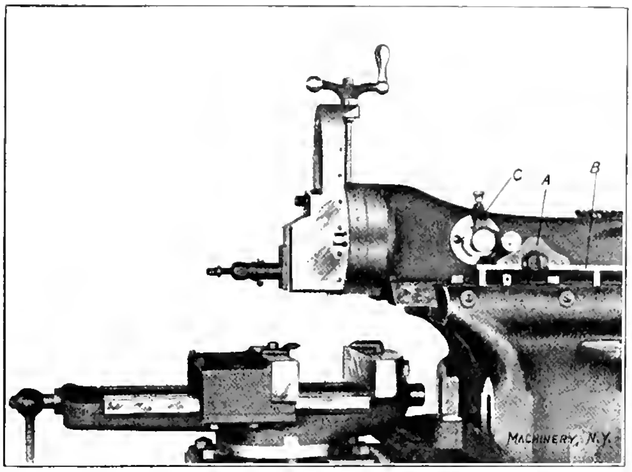


Bench Screw Slotter.

SHAPER ATTACHMENT.

Gould & Eberhardt, Newark, N. J., have recently fitted to their shapers a vertical feed attachment of unusually neat design, which adds materially to the usefulness of this tool as well as to the convenience of the workman. The accompanying half-tone, which shows a shaper equipped with the device, will give a clear idea of the construction of the feed motion. A rail *B* is attached to the top of the frame, alongside of the shaper ram, and a cam-shaped piece, *A*, may be clamped to this rail at any point desired, according to the length and position of the stroke of the shaper. A roll at-

tached to one arm of the bell-crank rides up on this cam at each stroke of the ram, and the other arm of the bell-crank carries a pawl which operates a ratchet wheel attached to the feed mechanism. The distance that the roll rides up on the cam, therefore, determines the number of teeth fed by the pawl at each stroke. It will be seen, therefore, that the cam *A* is the only part that ever needs adjustment, either for varying the amount of feed or to accommodate any change in the stroke of the shaper. A supplemental screw adjustment to the cam is in contemplation, for conveniently varying the feed from 1 to 10 teeth, after the cam is once set.

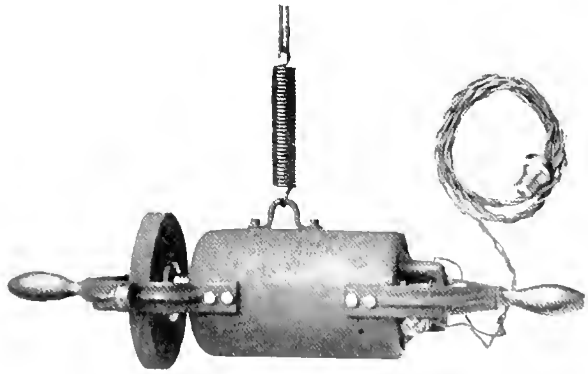


Vertical Feed Attachment.

PORTABLE "AERIAL GRINDER."

A very handy tool has recently been designed and placed on the market by the Hisey-Wolf Machine Co., Cincinnati, O. It is a "portable aerial surface grinder," electrically driven, and is illustrated herewith.

This grinder was particularly designed for irregular surface grinding, and the cleaning of castings of any kind or shape. It can be suspended anywhere, or counterbalanced from the ceiling or a traveler. The motor is enclosed, and especially built for the work for which it is intended. It has adjustable cone bearings, and detachable handles. The driving power is obtained from the ordinary incandescent lamp socket —direct current only. This machine can be carried to work in any part of the shop, which does away with the handling of heavy castings that require grinding, saving the loss of time and money for re-handling.


Hisey-Wolf Suspended Grinder.

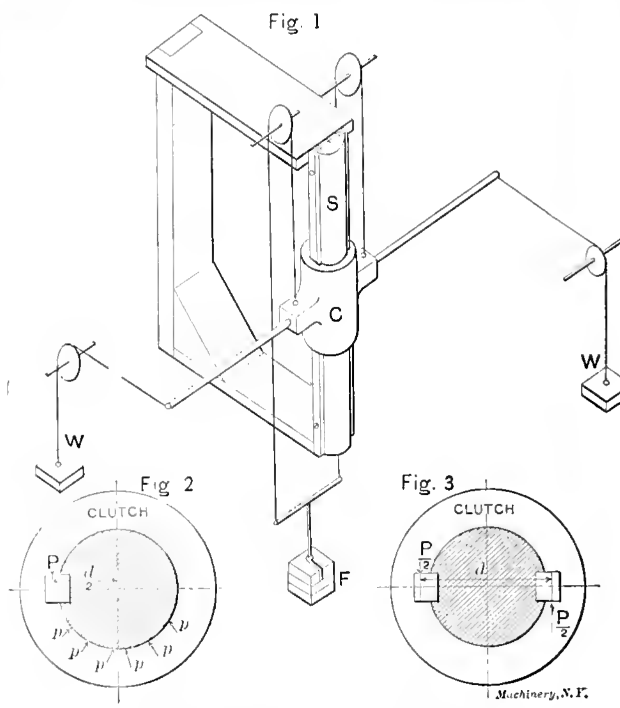
These machines are made in two sizes: ½ and 1 horse power, weighing 40 and 65 pounds, respectively. They are sent out complete, ready for work, as illustrated, with cord, socket and wheel.

* * *

FRICTION OF SLIDING KEYWAYS.

It is generally appreciated that a splined shaft used to transmit motion to a rotary part through which it slides meets with much resistance to sliding motion if the power transmitted is considerable. When the pressure is heavy the frictional resistance may become so great as to break some part taking the longitudinal stress, although apparently amply strong to meet the pressure of ordinary work. Even if breakdowns do not occur the keys or feathers wear out quickly and tend to make the splined shaft, which is an indispensable feature of machine tools and many other machines, a troublesome part. It is not, however, generally known, we believe, that two keyways, on opposite sides of a shaft which is to slide through and transmit rotary motion to a gear or wheel, greatly reduce the frictional resistance to longitudinal motion. A knowledge of this fact would often enable the designer to avoid serious troubles arising from the use of this class of transmitting mechanism.

A British civil engineer, having been called on to investigate and discover the cause for the failure of some large penstock sluice-valves of a dock which were worked by power through large clutches of the claw-tooth type, publishes the result of his investigation in *Engineering*. The clutch which caused the shaft to rotate was provided with only one key and it was suggested that the frictional resistance to longitudinal motion would be reduced by the use of two keys. The suggestion was followed with very successful results. After making the suggestion the engineer rigged up an experimental model, shown diagrammatically herewith, which demonstrated conclusively that where power is transmitted by a splined shaft the resistance to sliding motion is fully two times as great with one key as it is with two keys placed diametrically opposite.



Model Illustrating Friction of Sliding Keyways.

In the model the shaft *S*, Fig. 1, was 1½ inches in diameter, with keys in proportion, and was held in a vertical position in a frame, as indicated. One key was fixed in position and the other was movable, but capable of being fixed in place when required by means of countersunk screws. The clutch represented by the cylinder *C* was provided with the necessary keyways, and was capable of sliding along the shaft while subjected to a twisting couple, supplied by means of two equal weights acting upon the ends of the lever arms, through the medium of two pulleys. The weight of *C* was first balanced by means of the strings led vertically up from it and then down over the pulleys to weight *F*. Torsion was then applied to the clutch *C* by the means before described, and the two keys being fixed in position, it was found that a force represented by the weight of 3 pounds was required to just cause *C* to slide up the shaft. One key was then removed, and the force required to just cause *C* to slide was found to be 5 pounds. The result of this experiment showed that the frictional resistance of the clutch to sliding along shaft while transmitting power by means of two keys is only 60 per cent. of that met with when one key only is used. Further experiments confirmed this.

MACHINERY.

December, 1904.

AN EXPERIMENTAL GAS TURBINE.

DR. ALFRED GRADENWITZ.

It is a natural outcome of modern gas engine construction on one side, and the development of steam turbine building on the other, that endeavors should be made to combine the advantages inherent in both these rivals of the reciprocating steam engine.

The principle of a hot air turbine was enunciated as far back as 1853 by F. Redtenbacher in his book on the "Caloric Engine," where attention is drawn to the fact that a turbine would be an ideal motor to be propelled by hot air, as any difficulty resulting from unequal expansion of the parts would be done away with. The enormous speed of revolution necessary in a gas turbine, however, led him to think that a constructive realization of his idea would be impossible. Meantime, methods of gas engine construction have been immensely improved upon, while in designing steam turbines means of reducing the speed to suitable limits by dividing the pressure into steps have been found out, so that obstacles that were formerly insurmountable do not now present serious difficulties. The moment seems to have come for a successful gas turbine to be designed, and some solutions of the problem are now being attempted.

An interesting type of gas turbine, the so-called "fire turbine," due to Dr. F. Stolze of Berlin Charlottenburg, is attracting much attention at the present day, and it is fair to state that the inventor of this engine enunciated the principle of dividing the pressure into steps with a view to diminishing the speed in his first description of this turbine more than thirty years ago, at which time, however, patents were refused him by the Prussian Patent Office on account of the special conditions then attached to patenting. The matter was again taken up later on, when patents were readily granted both for the original invention and subsequent additions to the same. Although the realization of the idea might have been difficult to carry out at the time of its being first conceived, there are no such difficulties in the way now and the experimental plant of 200 horse power, illustrated in Fig. 2, is nearing completion.

The underlying principle consists in compressing the atmospheric air to a moderate tension—say $1\frac{1}{2}$ atmospheres above atmospheric pressure—and in afterward heating this compressed air so that it will assume a volume 2 or $2\frac{1}{2}$ times as great at the same tension. After this the air is allowed to expand again to atmospheric pressure, while passing through the passages of the turbine. The energy available for doing work upon the vanes of the turbine, is due to the increase in volume resulting from the heating of the air. The process is carried out as follows: By means of a compression system consisting of ten turbine wheels or runners arranged one behind another on a conical drum, atmospheric air at a temperature of, say, 15 degrees C. is compressed adiabatically until a point is reached where its pressure is equivalent to that of $2\frac{1}{2}$ atmospheres. During this process, its temperature rises by 103 degrees C., leaving 282 degrees C. to be provided for by the heat of the furnace in order to bring the air up to the

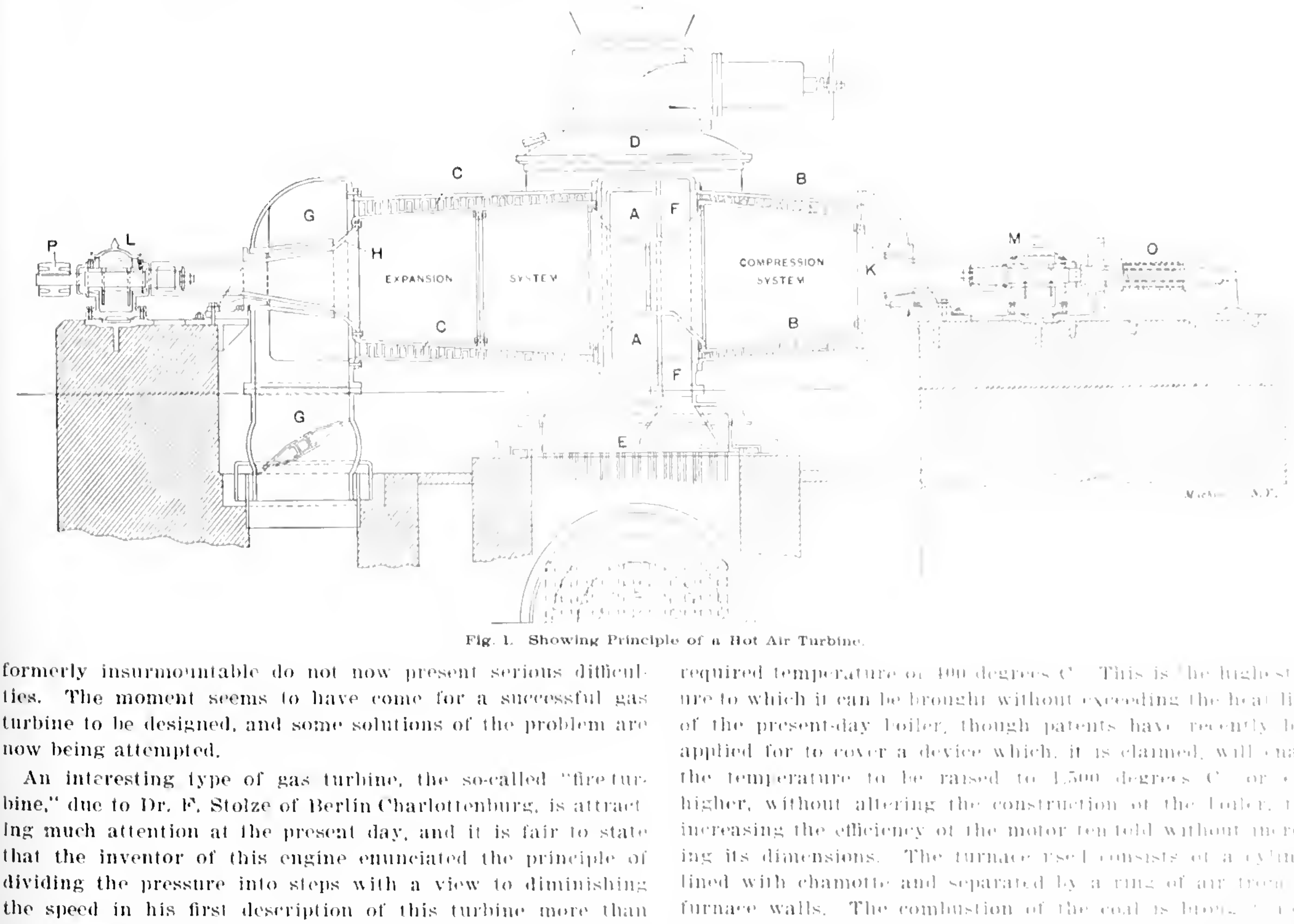


Fig. 1. Showing Principle of a Hot Air Turbine.

required temperature of 400 degrees C. This is the highest figure to which it can be brought without exceeding the heat limit of the present-day boiler, though patents have recently been applied for to cover a device which, it is claimed, will enable the temperature to be raised to 1,500 degrees C. or even higher, without altering the construction of the boiler, thus increasing the efficiency of the motor ten fold without increasing its dimensions. The furnace itself consists of a cylinder lined with chamotte and separated by a ring of air from the furnace walls. The combustion of the coal is brought about by means of a part of the compressed air passing through the grate, and the carbon monoxide thus formed is converted into carbon dioxide on issuing into the surrounding ring-shaped space, which contains the remainder of the compressed air as yet only partially heated. By a special regulation device, the supply of compressed air is so controlled as to maintain a constant temperature of 400 degrees C. The compressed air, having been mixed with the heated gases now streams toward the expansion system, which comprises the turbine, and is mounted on the same axle as the compression system. In passing through the expansion system the compressed air is expanded down to one atmosphere, during which process it cools to 243 degrees C. In order to avoid wasting the heat contained in the exhausted gases at this high temperature, they are now conducted through a tubular heater which is

A great deal of attention is now being given to the question of the gas turbine, both in this country and in Europe. Although much experimental work has been carried on, the apparatus of Dr. Stolze, described in this article, is the first to be so far perfected as to attract the attention of engineers generally. While his work has not progressed so far as to enable one to predict whether he will achieve success in his endeavors, his apparatus is of unusual interest because it is a pioneer in what is destined to be an important field.

located between the compression system and the furnace. The exhausted gases therefore raise the temperature of the compressed air during its passage from the compression system to the furnace. As stated above, the air when leaving the compressor has a temperature of 118 degrees C., which is raised to about 180 degrees C. in the heater before it reaches the furnace. It therefore remains for the furnace to raise the temperature of the air by only 220 degrees in order to reach the initial temperature of 400 degrees, at which the air and gases pass to the turbine.

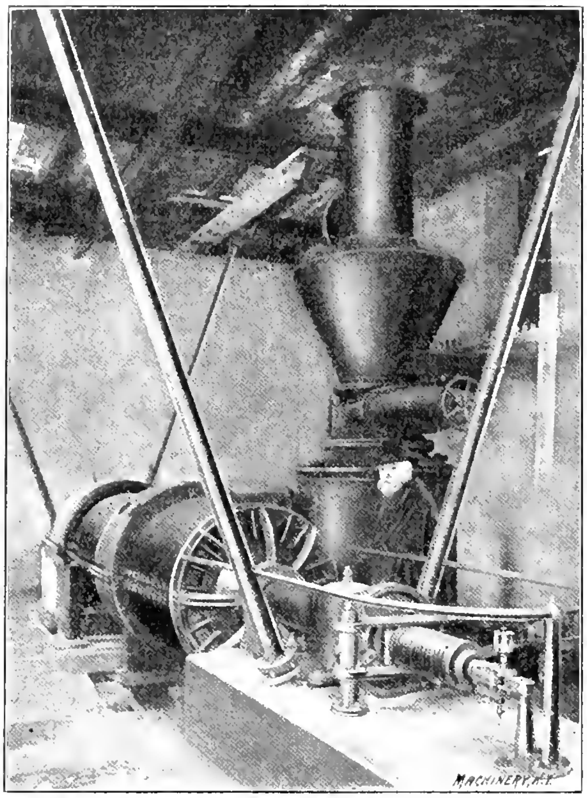


Fig. 2. Two-hundred H. P. Experimental Plant.

In Fig. 3 is a diagrammatic sketch of Dr. Stolze's invention, showing in outline the arrangement of the compression and expansion systems comprising respectively the air compressor and the turbine motor. In casing *A* on shaft *I* is seen a set of "fire-turbines." The outlet of *A* is at *C*, and the inlet (not shown in the sketch) at the opposite end of the turbine set. On the same shaft is placed a larger set of turbines in casing *B*, which has an inlet at *E* and an outlet at the opposite end. The two pipes *C* and *E* communicate with the heating device,

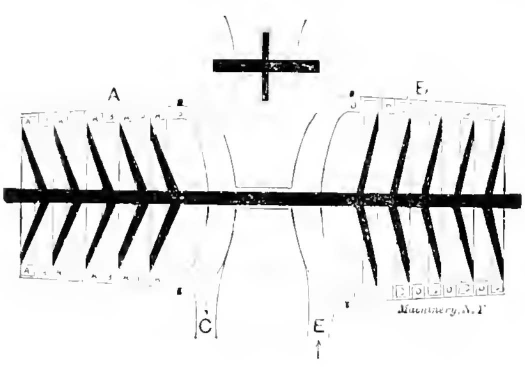


Fig. 3.

whereby the temperature of the motor fluid can be raised. The apparatus is operated as follows: Shaft *I* is made to rotate in the direction of the outer ends of the turbine blades in *A*. The set of turbines in casing *A* will then draw in the air, compress it, and finally deliver it in the compressed state through *C* to the gas producer or any other calorific medium provided. The gases generated in the producer pass in the heated state through *E* into *B*, where their motive force is utilized by the turbines. The energy developed in the larger casing, *B*, will obviously exceed the energy required to draw the cold air into *A*, so that the apparatus becomes self-driving, developing energy for motive power. *aa*, etc., are the vanes of the rotating elements of the compressor, and *bb* the stationary guide vanes; *cc*, etc., are the moving vanes of the turbine motor, and *dd*, etc., are the guide vanes. If desired, the expansion and compression systems may be duplicated, which will be found useful to avoid end thrust on the shaft. To prevent the direct passage of air from *A* to *B*, the device shown diagrammatically in the upper part of Fig. 3 may be made use of. This consists of an annular casing on the hollow tube through which the shaft passes, fitting close to a disk on the shaft. The disk may be grooved or scored to prevent the flow of air over its surface. It is interesting to note the similarity of this device, designed thirty years ago, to the device of the labyrinth used by Parsons in the construction of his turbine.

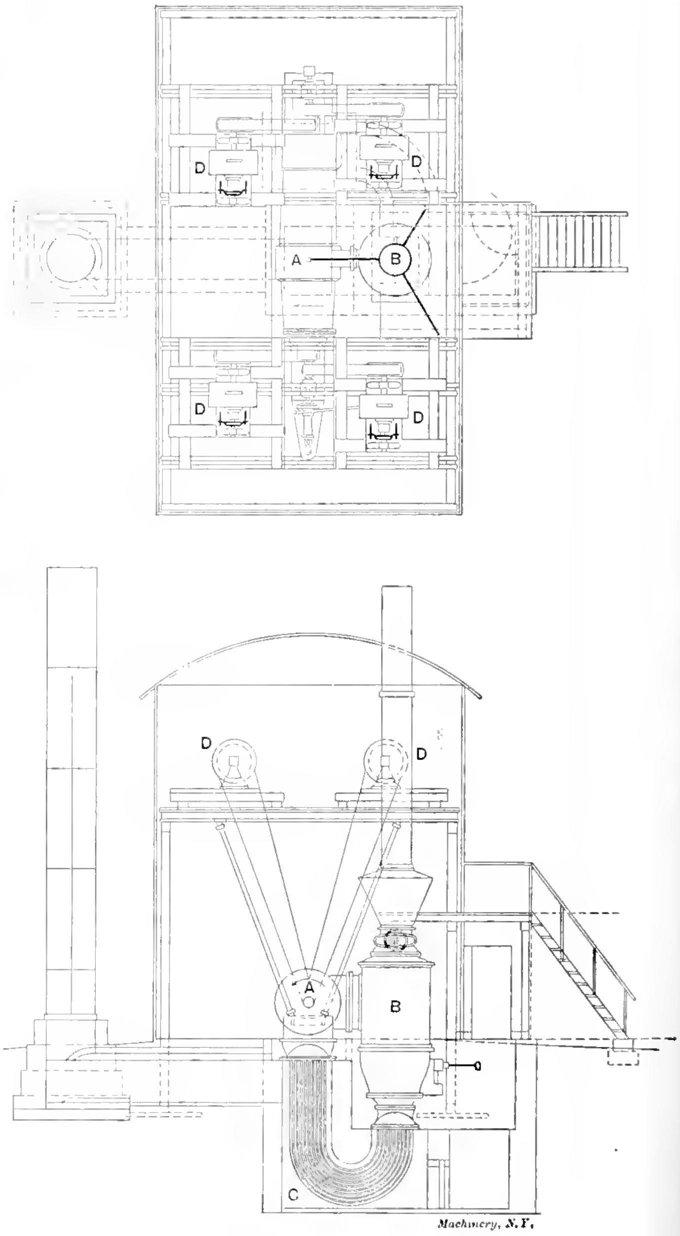


Fig. 4. Sectional Elevation and Plan of Plant.

In consequence of friction between the fuel particles, it might happen that considerable reaction or back pressure would be produced, retarding the motion of the heating gases and air, and to some extent preventing perfect combustion. This possibility is eliminated by either of the two devices shown in Figs. 5 and 6, whereby the supply of combustible gases and compressed air is so arranged that they flow into the mixing chamber in the same direction, and each of the two currents has a tendency to draw the other along with itself. Back pressure is thus avoided. In these cuts *A* is the furnace, *B* the mixing chamber for the combustible gases and compressed air, *N* the place where the combustion of the carbonic oxide gas occurs, *M* a funnel through which fuel is supplied, *V*

the grate, C the passage for the compressed air from the compression turbine, D the passage for the compressed air into the mixing chamber, E the passage for the supply of air to the furnace, while F and G show the method of introducing gases and air in parallel directions.

Figs. 1 and 4 show more completely the arrangement of the hot air turbine, and of the plant containing it. In Fig. 1 the apparatus is seen, consisting of a large shell in the form of a double cone, one end of which is the expansion or motor end and the other end, K, comprises the compression part. On the compression end is a series of rings of vanes attached to the drum and alternating with stationary rings of vanes. On the other end are similar vanes, comprising the expansion system. The air is drawn in through the passage between the vanes indicated at BB, and is delivered to the chamber FF from which it passes through the tubular heater E to the furnace D. It then enters the annular space, AA, and passes through the passage between the vanes CC to the exhaust chamber, GG, and thence to the tubes of the heater, E. LM are the bearings at the two ends, O is the governor, and P the pulley from which power is taken off the belt.

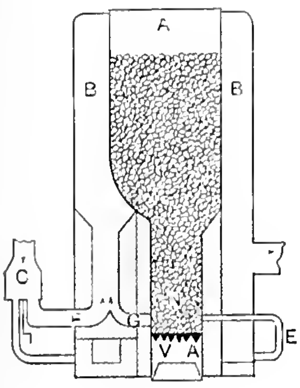


Fig. 5.

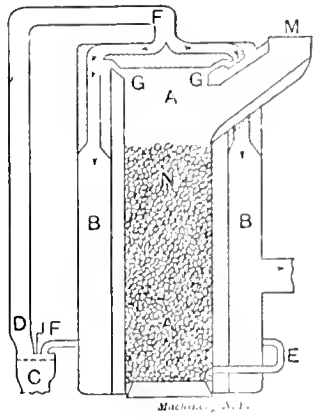


Fig. 6.

In Fig. 4 appears a sectional elevation and a plan of the whole plant. A is the turbine and compressor, B the furnace, C the heater, and DD the electric generator driven by the turbine.

One of the principal advantages of hot air turbines over steam turbines is their relatively low speed of revolution, at most 2,000 revolutions per minute with a maximum diameter of 1 meter. The main advantages, however, are that every bit of fuel consumed is utilized for power generated, no heat of escaping exhaust gases being lost, and that the air does not require previous vaporization as does water, an important item when we consider that to produce 1 kilogram of steam at atmospheric pressure consumes over 600 calories, while yet further heat is needed to induce working energy in the steam. It is claimed that the 200 horse power motor now in course of construction will insure a saving in the fuel consumed as high as 33 1-3 per cent. of that used in a steam engine plant.

* * *

We recently published a note in regard to the use of compressed air for maintaining water pressure where there was no available head of water. Our attention has since been drawn to an installation of the Acme Water Storage & Construction Company at the St. Louis Fair, which operates on this principle and is intended to make possible a constant supply of water under high pressure, thus displacing water towers and elevated tanks. The apparatus consists of two tanks, an air compressor, and a pump. One tank is kept constantly charged with air at a high pressure, while the second contains both air and water, the water being forced in by a pump, and the air being admitted from the first tank by a pressure reducing valve set to give constant pressure. As the water is pumped into the water tank, the air is removed by the compressor and returned to the air tank, so the pressure is always uniform. It is only necessary to run the compressor and pump when charging the system, for the apparatus is so arranged that the entire contents of the water tank may be used under a constant pressure before charging again. The Deane vertical pump was used with the apparatus exhibited.

VARIABLE SPEED MOTORS.—8.

THE STOW MULTI-SPEED MOTORS.

WM. BAXTER, JR.

In previous articles we have explained several methods for varying the speed of motors by varying the strength of the magnetic field in which the armature rotates. In all these arrangements the field strength is varied by electrical means, that is, by varying the strength of the magnetizing current that passes through the shunt field coils. It is possible, however, to vary the strength of the motor field by mechanical means, and this is the method employed in the Stow multi-speed motors.

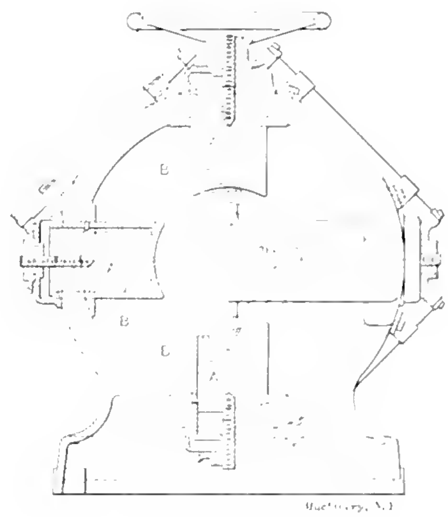


Fig. 1

The mechanical method of varying the strength of the motor field complicates the construction somewhat, but on the other hand it increases the range of speed variation obtainable with a motor of a given size; that is, this result is obtained if the construction is such as is used in the Stow motors. A brief explanation of the principles involved in obtaining speed variation by means of changes in the field strength will serve to make the matter clear.

Principles of Commutation.

For a motor to run without injurious sparking at the commutator it is necessary that the strength of the motor field be sufficient to counteract the effect of the armature reaction. In a two pole motor the current flows through the armature

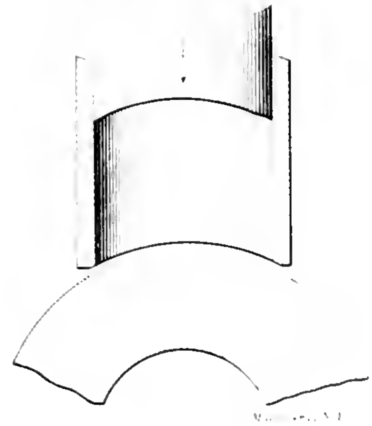


Fig. 2

coils in one direction while they are passing through one half of the revolution, and in the opposite direction while passing through the other half. At the instant when a commutator segment passes under the brush, the current flowing in the coil connected with this segment and the one back of it, must reverse its direction. To accomplish this result the field magnetism at this point must be in the right direction to induce a reverse current, and of proper strength to develop a current equal to that flowing in the other coils. If this is done there will be no sparking at the brushes. If a motor runs with a uniform load, and at a uniform speed, there is no difficulty in

accomplishing this result, but if the load varies the reaction of the armature will vary and if the speed varies it must be produced by a variation in the field strength, and both these actions will result in disturbing what we might call the commutation balance, so that sparkless operation cannot be obtained. In practice, a considerable variation in the field strength can be obtained without producing a noticeable increase in the sparking, but with the standard designs of stationary motors this variation is seldom more than 20 or 30 per cent. To obtain a speed variation of say two to one by means of field strength variation obtained by varying the strength of the field magnetizing current, it is necessary to make the motor considerably larger than for constant speed work, so that the armature may be reduced and the field increased. This change reduces the relative effect of the armature reaction, so that when the field strength is varied, its direction is not materially changed, and as a consequence the sparking at the brushes is not increased.

Perfect commutation does not depend upon maintaining the strength of the magnetic field within proper limits over the entire surface of the poles, but only over that portion that the armature coils pass through while the act of commutation is

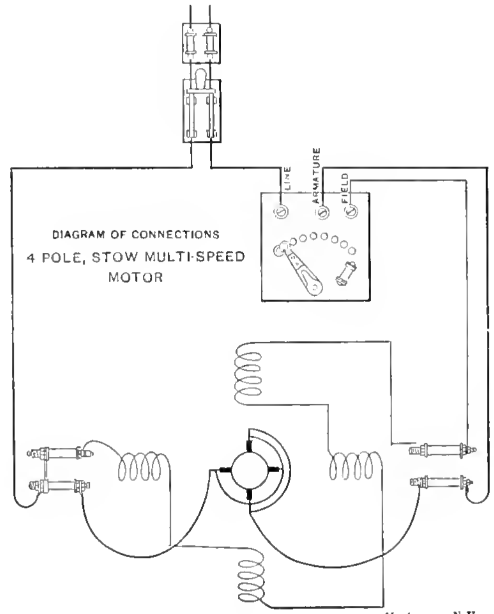


Fig. 3.

taking place; in other words, over the portion through which the coils pass as they are short-circuited by the commutator brushes. This portion of the magnetic field is developed by the edges of the pole pieces, so that if at these points the magnetism can be kept practically constant it matters little how much it may vary over the balance of the pole surface.

When the field is varied by varying the strength of the magnetizing current, the strength of the magnetic field varies alike over the whole of the polar surface, hence, only a comparatively small change can be effected in the magnetic density before the commutator brushes begin to spark badly.

Mechanical Method of Varying the Field Strength.

The strength of the field of a motor is varied mechanically by varying the distance between the surface of the poles and the surface of the armature core. This variation in the distance between the surfaces of the two parts varies the field strength, owing to the fact that iron does not resist being magnetized as much as air, or as it is commonly stated, the magnetic reluctance of iron is much lower than that of air. If the poles are drawn away from the armature the strength of the magnetic field is reduced. The reduction, however, will be uniform over the whole polar surface. This method of varying the field strength was embodied in several designs of motors made in the early days of electrical development, but it did not survive, owing to the fact that it produces precisely the same result as is obtained by varying the strength of the magnetizing current and has no advantage to offer to offset the increased cost of making the motor.

Principle of the Stow Multi-speed Motor.

The Stow multi-speed motor is constructed upon a modification of this principle which, while apparently small, produces decidedly different results.

A clear understanding of the construction of this motor can be obtained from Fig. 1, which is a sectional vertical elevation at right angles to the shaft. The poles of the motor are

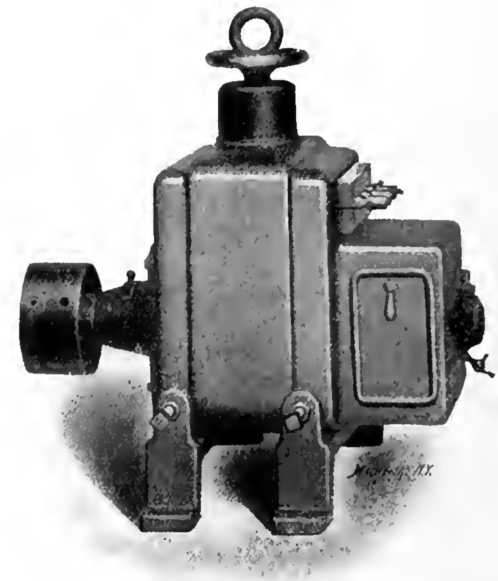


Fig. 5.

made up of a stationary shell, *B*, and a movable core, *A*, both parts being made of iron. The cores *A* of the several poles are moved in a radial direction by means of the handwheel seen at the top, and the miter gear connections, so that all the cores move equally. When the cores are in the closest position to the armature, the air space is reduced to the minimum point, and as a consequence the field strength is the greatest.

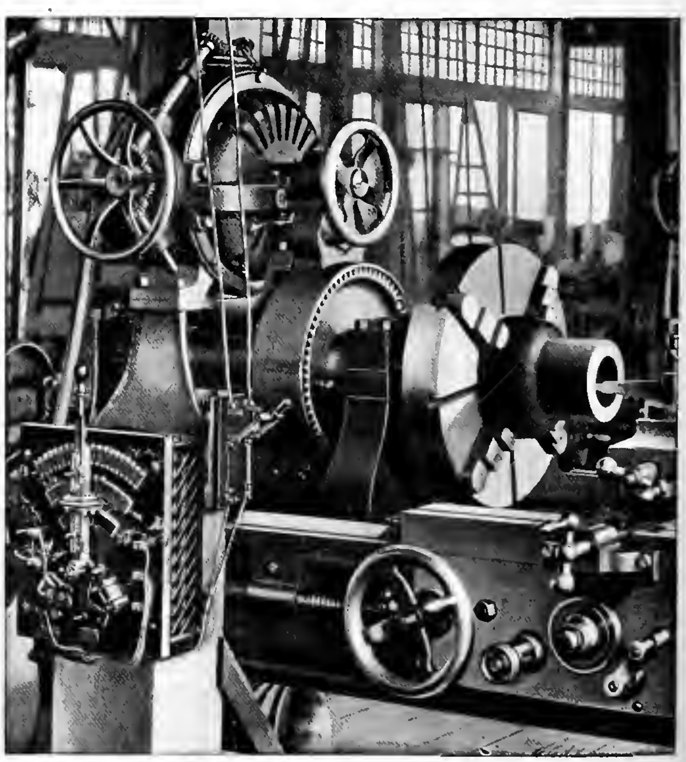


Fig. 4.

As the cores *A* are withdrawn from the armature, the length of air interposed in the magnetic path is increased, and as a result the strength of the magnetism is reduced. When the cores are withdrawn as far as they will go, the magnetic field is reduced to the lowest point. From this it will be seen that by varying the position of the cores *A*, the strength of the field is varied, and thereby the speed of the motor is changed.

It will be noticed in Fig. 1 that at all times the distance between the end of the outer casing, *B*, and the armature remains the same; hence, the resistance to the flow of magnetism along this path remains unchanged, and as the magnetizing current also remains unchanged, the magnetic strength of the field between the armature and the end of casing *B* does not vary to any appreciable extent. It is this magnetism that acts upon the armature coils when they are passing under the brushes, and are undergoing commutation;

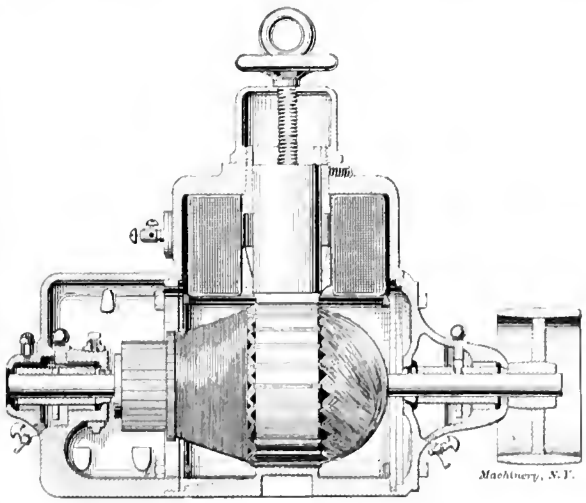


Fig. 6.

therefore, the act of commutation is as perfectly performed when the cores *A* are far removed from the armature, as when they are near by. In fact, the changing of the position of these cores only changes the strength of the magnetism flowing from the central portion of the pole surface, and thus varies the total amount of magnetism acting on the armature, and thereby the speed of the latter, but without interfering with the sparkless operation of the brushes. The practical result of this action is that a motor of a given design can be made to vary its velocity through a much wider range than if the variation were obtained by changing the strength of the field magnetizing current.

Speed Variation of Motors.

The average stationary motor, not intended for variable speed work, will not run well at the brushes if the speed is varied much above 30 per cent.; but a machine of the same size and electrical proportions, if provided with the movable cores *A* can vary its velocity in the ratio of 2½ to 1 without injurious sparking at the commutator. To obtain this same range of speed variation by varying the strength of the field

110 VOLT 6 H.P. STOW MOTOR

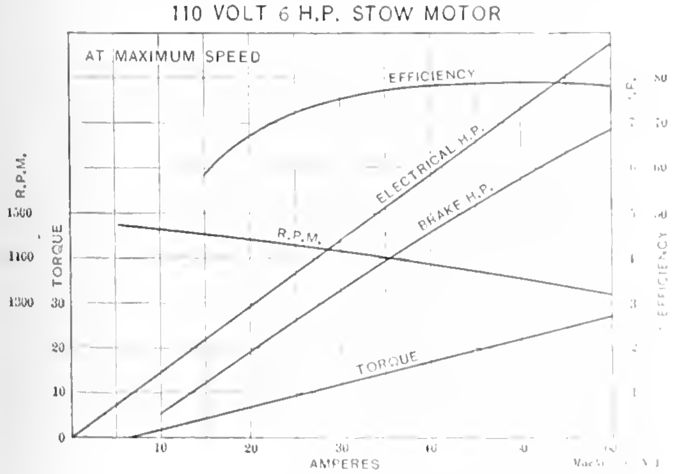


Fig. 7

current it would be necessary to make the motor much larger.

Thus it will be seen that the effect of the Stow construction is to increase the range of speed variation without increasing the size of the motor.

Modifications in the Construction of the Movable Cores.

In Fig. 1 the cores *A*, when in the position nearest to the armature, are some distance away from the pole surface, the casings *B* being constructed with a thin bottom which forms the actual polar face. In some of these motors, however, the cores *A* project through the end of the casings *B* so as to come flush with their inner ends, as shown in Fig. 2.

Motor Starter.

As already explained, the Stow multi-speed motor owes its speed variation to changes in the reluctance of the magnetic circuit. The electrical circuits remain unchanged under all conditions and hence no electrical controller, rheostat or circuit-changing device is required to vary the speed. A simple motor starter, such as is used with constant-speed stationary motors, is all that is required; the connection with the starter, the line wires and the motor for a four-pole motor, being as shown in Fig. 3. For operation with machines that have to be driven in opposite directions, a reversing motor starter is required, as shown in Fig. 4, which shows a Stow motor mounted upon a lathe, and provided with a reversing motor starter.

Bi polar Stow Multi-speed Motors.

Multi-speed motors are made of the bi-polar, as well as the multi-polar type. Fig. 5 shows the external appearance of a bi-polar machine. With this type of motor no miter wheel gearing is used for connecting the movable pole cores. The gearing is dispensed with by constructing the motor so that there is only one movable core. The construction is clearly shown in Fig. 6, which is a vertical sectional view of Fig. 5 taken parallel with the shaft.

Efficiency of the Stow Motor.

There is nothing in the construction of these motors that can prevent them from being just as efficient as those in which

110 VOLT 6 H.P. STOW MOTOR.

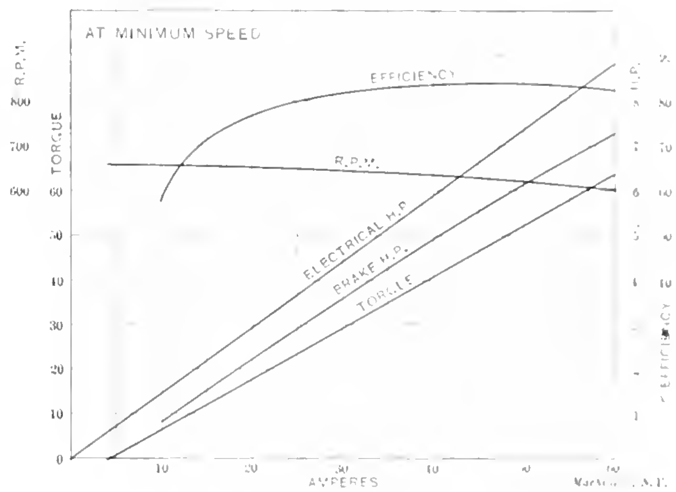


Fig. 8

speed variation is obtained by changing the strength of the field magnetizing current. The latter type may be able to show a slightly higher efficiency at high velocities, owing to the fact that then the field current is reduced, and thus a slight saving is made. But the total amount of energy required to magnetize the field is so small, from 2 to 3 per cent. of the whole, that the difference amounts to nothing, practically considered.

The efficiency of Stow motors when running at the maximum and minimum velocities with variable load is shown in the two diagrams, Figs. 7 and 8, which show the performance of a 6-horse-power motor of the four-pole type.

The advantages claimed for the Stow multi-speed motor are: That it gives a speed variation of 2½ to 1 with a machine of a given size, which, if wound for the same horse-power, and arranged to vary the speed by varying the strength of the field magnetizing current, would not give a speed variation much more than half as great; that practically the same power is given at all speeds; that the same efficiency is obtained at all velocities; that the speed remains unchanged when the load changes (this result being accomplished owing to the fact that no armature resistance is used to vary the speed), and, finally, that an infinite number of speeds can be obtained between the highest and the lowest, this being due to the fact that the cores *A* can be moved to an infinite number of positions.

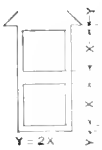
DIRECTIONS FOR DRAWING D. C. COILS.

OSCAR STEGEMAN.

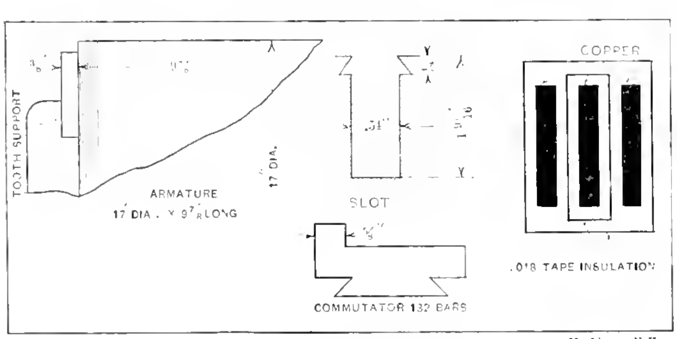
Example: Armature Connected Straight.

Given: 44 slots, 132 coils, each coil consisting of one turn ⅛ inch by ½ inch copper. Wind No. 1 to No. 12; connect No. 1 to No. 2. 1-32 inch clearance between insulated groups. Insulation per group equals 4 × .018 = .072 inch. This allows for shellac, etc.

Solution. Draw a semicircle with a radius equal to that of the armature. Divide this semi-circle into half as many parts as there are number of slots in armature. Let the distance from point *A* on center line to slots Nos. 1 and 12 be equal. Draw the bare groups of coils in slots as in sketch, $Y = 2X$. Then draw the rear view; the part *B-C* as an arc of a circle with the armature center as the center for the radius. Draw the part *D-E* straight to the right from *D* until its runs tangent to an arc of a circle with a radius whose center is on a line running through center of armature and center line of slot No. 12. The distance from *C* to *D* is equal to twice the radius R_1, plus width of copper strap.



Then on the plan view draw center line *a a'*, this being the center line for the bending pin for bending rear end of coil. This line also to run through center of R_2. For the pitch of the coils, set off from center line of R_2 "*n*" number of equal parts—the length of these parts equal to the distance between two slots projected on lower edge of respective groups. In this case set off $b\ c = 4$ (*F-G*); *F-G* equal to projection of 2 slots projected on lower edges of *B-C*. $b'\ c' = 4$ (*H-I*) *H-I* equal to projection of two slots projected on lower edge of *D-E*. Take *c* and *c'* as centers for arcs of circles with radii (R_3) = *n* (thickness of group + insulation + clearance between insulated groups) + R_2. In this case 4 (.375 + .072 + .03125) + .25 = 2.165". The tangents of these arcs and of R_2 are the pitch of the group. From the center line develop the distances *C* to *B* and *D* to *E*. The developed length obtained from lowest edge of group. For center of R_4 for lower part of group, let coils project ⅜ beyond the tooth support (in this case ⅜ + ⅜ = ¾" beyond armature). For upper part of group this dimension must be scaled. Draw two lines a short distance apart, to denote the length of armature iron. As the developed distances from *E* to *D* and from *E* to *L* are not alike it is necessary, to obtain accuracy, to develop the front parts of coil separately. Draw center line *f-f'* and *g-g'* a slight distance to the right and left. Then place R_5 for both upper and lower parts of group the same distance beyond the tooth support as R_4 for the lower part of group. Then set off from *d* to *e* the same distance as from *b* to *c*. From *d'* to *e'* set off the same number of spaces as from *b'* to *c'* using the



Example of Armature Details.

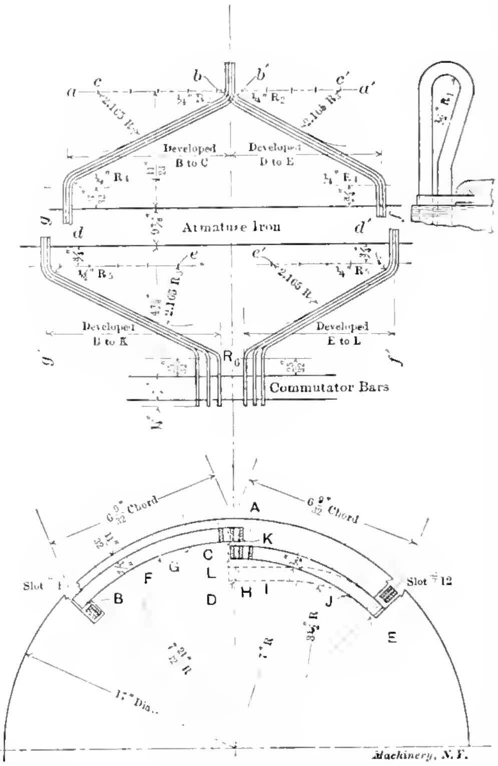
distance *E-J* instead of *H-I*. With *c* and *e'* as centers draw arcs of circles with R_3 as a radius. The tangents of these arcs and of R_5 are the pitch of the group for the front part of coil. To determine center of R_6 and also developed distance *B* to *K* and *E* to *L*, a few trials are necessary. Draw an arc of a circle from *B* to *K* with armature center as center for radius. Likewise from *E* to *L*. Center of R_6 should be ¾ inch from edge of commutator bars. This is obtained by moving the ends of coils to the right or left until the developed distance from *B* to *K* and from *E* to *L* are such as will bring

*This article may be properly considered a part of the data sheet contributed by Mr. Stegeman this month, and is published in the reading columns so that it may appear in the same number with the data sheet.

center of both R_6 on exactly the same line. Then draw the commutator bars ¾ inch further on and let the coils extend ¼ beyond. The distance from coil No. 1 to coil No. 2 is a space set off on the armature circumference equal to 1-3 of the distance from center line of one slot to center line of the next. After the plan view has been finished the end view is to be completed. Draw in the ends of coils and give dimensions, except R_3, as shown in diagram. These dimensions are all to be scaled from the drawing, and are sufficient for making a former.

Example: Armature Connected Cross.

Given: 44 slots, 132 coils, each coil consisting of one turn ⅛ inch by ½ inch copper Wind No. 1 to No. 12. Connect No. 1 to No. 67. 1-32 inch clearance between insulated groups. Insulation per group = 4 × .018 = .072 inch. This allows for shellac, etc.



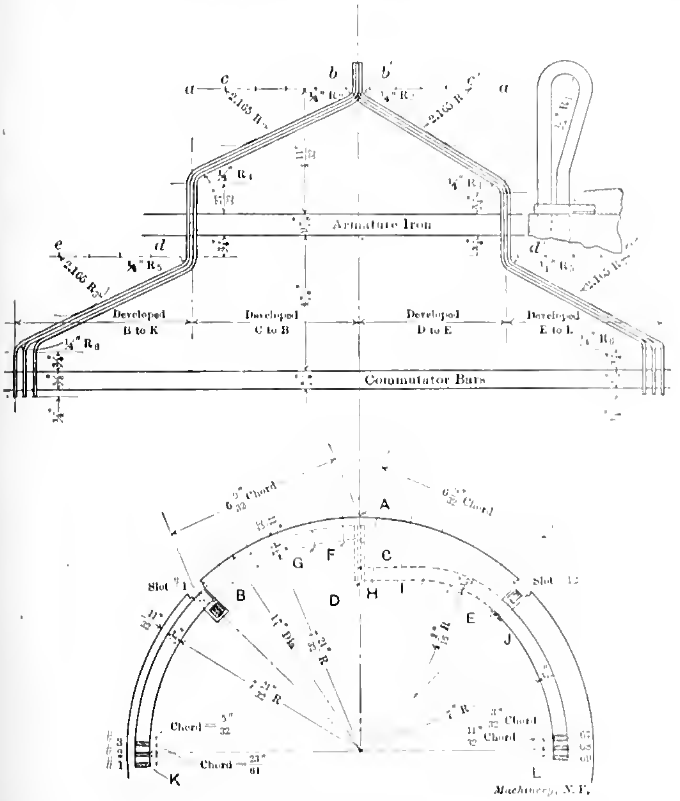
Method of Laying Out D. C. Coil Forms. Barrel Winding Armature Connected Straight.

Solution. Draw a semi-circle with a radius equal to that of the armature. Divide this semi-circle into half as many parts as there are number of slots in armature, and let the distance from point *A* on center line to slots Nos. 1 and 12 be equal. Draw bare groups of coils in slots as in small sketch. $X = 2Y$. Then draw the rear view, the part *B-C* as an arc of a circle with the armature center as the center for the radius. Draw the part *D-E* straight to the right from *D* until it runs tangent to an arc of a circle with a radius whose center is on a line running through center of armature and center line of slot No. 12. The distance from *C* to *D* is equal to twice the radius R_1 + width of copper strap.

Then on the plan view draw center line, *a-a'*, this being the center line for the bending pin for bending rear end of coil. This line also to run through center of R_2. For the pitch of the coils, set off from center of R_2 "*n*" number of equal parts, the length of these parts equal to the distance between two slots projected on lower edge of respective groups. (In this case set off $b\text{-}c = 4$ (*F-G*), *F-G* equal to a projection of two slots projected on lower edge of *B-C*. And $b'\text{-}c' = 4$ (*H-I*) *H* equal to a projection of two slots projected on lower edge of *D-E*. Take *c* and *c'* as centers for arcs of circles with radii (R_3) = *n* (thickness of group + insulation + clearance between insulated groups) + R_2. In this case 4 (.375 inch + .072 inch + .03125 inch + .25 inch = 2.165". The tangents of these arcs and of R_2 are the pitch of the group. From the center line develop the distances *C* to *B* and *D* to *E*. The developed length obtained from lowest edge of group. For center of R_4 for lower part of group, let coils project ⅜ beyond the tooth support (in this case ⅜ + ⅜ = ¾" beyond armature),

For upper part of group this dimension must then be scaled. Draw two lines a short distance apart, to denote the length of armature iron. Then place R_5, for both upper and lower part of group, the same distance beyond the tooth support as R_4 for the lower part of group. Then set off from d to e the same distance as from b to c. From d' to e' set off the same number of spaces as from b' to c', using the distance E-J instead of H-I.

With e and e' as centers, draw arcs of circles with R_3 as a radius. The tangents of these arcs and of R_5 are the pitch of the group for the front part of coil. To determine center of R_6 and also developed distance B to K and E to L, a few trials are necessary. Draw an arc of a circle from B to K, with armature center as center for radius. Likewise from E to L. Center of R_6 should be ¾ inch from edge



Method of Laying Out D. C. Coil Forms. Barrel Winding Armature Connected Cross.

of commutator bars. This is obtained by moving coils Nos. 1, 2 and 3, and 67, 68 and 69, up and down until the developed distances from B to K and from E to L are such as will bring center of both R_6 on exactly the same line. Then draw the commutator bars ¾ inch further on and let coils extend ¼ inch beyond. The distance from coils Nos. 1 to 67 is 66 equal spaces, set off on the armature circumference, each space equal to 1-3 of the distance from center line of one slot to the center line of the next. After the plan view has been finished, the end view is to be completed. Draw in the ends of the coils and give dimensions, except R_3, as shown in diagram. These dimensions are all to be scaled from the drawing and are sufficient for making a former.

* * *

"BEAMS AND PLANES ECCENTRICALLY LOADED."

Editor MACHINERY:

As Mr. Blake, in his letter in the October, 1904, issue of MACHINERY, asks why I assumed the origin of axes at B with direction OB, also for me to extend my method to a spider having five arms, I offer the following explanation: It is a well-known principle that when a system of parallel forces is in equilibrium, the algebraic sum of their moments about *any* set of rectangular axes in a plane perpendicular to the forces is zero. In other words, the location of the origin and the direction of the axes may be fixed to suit one's fancy. It is consequently correct to assume some convenient point for the origin and through that point draw the axes in a convenient direction. It is a practical convenience to locate the axes so that one force passes through the origin, thus eliminating its moments from the moment equations. Then by drawing the axes through as many of the other forces as possible (generally only one other is possible) more terms may be eliminated from the moment equations. It will be understood then that my reason for selecting the particular point B for the origin was because it is correct and convenient, not that it is a better location than any of the other four points, A, C, D, or O. Similar reasons determined OB as the direction for the X axis. It would have served the purpose just as well to have passed the X axis through any of the other points, A, C, or D; or the Y axis through any of the points, A, C, D, or O.

In the light of the foregoing Mr. Blake has a right to and is correct in assuming axes as he has done. Since the location of the axes is immaterial we may take moments of the forces, as I determined them, about the axes Mr. Blake has assumed and we will find that their algebraic sum is, within an allowable per cent of error, equal to zero. The error arises from using the dimensions within the nearest eighth of an inch to the scaled dimensions. If we take moments of the forces, as determined by Mr. Blake, about the same axes we find that their algebraic sum is not zero, consequently the system of forces is not in equilibrium. When a load is supported by a frame of any kind the reactions are so distributed that, when taken with the load, they form a system of forces which is in equilibrium, hence any method of determining reactions which does not give a system of forces in equilibrium is incorrect.

There should be no difficulty in extending the method I gave for a four-armed spider to the case of a five-armed spider. The method, simply stated, is to so proportion the reactions that the resulting system of forces is in equilibrium, as this is a fundamental requirement, and then design the arms in accordance with the assumptions made when proportioning the reactions. E. E. GRAHAM.

Cleveland, Ohio.

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ANNUAL A. S. M. E. MEETING.

The annual meeting of the American Society of Mechanical Engineers will take place on December 6 at the headquarters of the Society, No. 12 West Thirty-first Street, New York City. The opening session will be on Tuesday evening, December 6, at 9 P. M., when President Ambrose Swasey will deliver the annual address. Following is a list of the papers to be read and discussed at the different sessions:

Wednesday morning, December 7, at the Hall Mendelssohn Union, 113 West Fortieth Street: "A New Hydraulic Experiment," by A. F. Nagle; "A Twist Drill Dynamometer," W. W. Bird and H. P. Fairfield; "Diamond Tools," Gus P. Henning.

Thursday morning, also at Mendelssohn Hall: "Centrifugal Fans," A. J. Bowie, Jr.; "Computation of Values of Water Powers and Damages caused by Diversion of Water used for Power," Charles T. Main; "An Indicating Steam Meter," Charles E. Sargent; "Staybolts, Braces and Flat Surfaces; Rules and Formulas," Robert S. Hale, and "Condensers for Steam Turbines," George I. Rockwood.

Thursday afternoon, Mendelssohn Hall: "Bursting of Four-foot Flywheels," Charles H. Benjamin; "Influence of the Connecting Rod upon Engine Forces," Sanford A. Moss; "Losses in Non-conducting Engines," James B. Stanwood; "Power Plant of Tall Office Buildings," Stirling H. Bunnell; "Pressures and Temperatures in Free Expansion," A. Borsody and R. C. Cairncross.

Friday morning, December 9, at 10 o'clock, at the Society House: "Fuel Consumption of Locomotives," George R. Henderson; "Road Tests of Brooks Passenger Locomotives," E. A. Hitchcock; "Discharge of Water with Steam from Water-tube Boilers," A. Bement; "More Exact Method for Determining the Efficiency of Steam-generating Apparatus," A. Bement; "Forcing Capacity of Fire-tube Boilers," Francis W. Dean.

The list of officers to be voted for, as presented by the Nominating Committee is: For president, John R. Freeman, Providence, R. I.; for treasurer, Wm. H. Wiley, New York; vice-presidents, S. M. Vauclain, Philadelphia; H. H. Westinghouse, Pittsburg, and Fred W. Taylor, Philadelphia; managers, George M. Brill, Chicago; Fred J. Miller, New York, and Richard H. Rice, Lynn, Mass.

STRENGTH OF BEAMS WITH RIBBED SECTIONS —A PARADOX.

WM. N BARNARD.

Is it possible for a beam which is broken part way through, to have greater strength than it had originally? Or, what is the same thing, Can a given beam be made stronger by reducing the area of its cross section?

These seem to be absurd questions and probably few people would hesitate to answer in the negative. For the usual cases, that answer would be correct, but it is a curious fact that there can be instances when it would not be.

We naturally, at first, think of the beam with a rectangular section. Any reduction in the area of this section will always decrease the strength of the beam. The same will be true of beams with circular and with polygonal sections, whether solid or hollow. It is also usually true of the ribbed section, such as the T, L and channel, but there may be exceptions. It is generally supposed that the addition of a rib will *always* increase the strength of a beam-member. If added properly the rib *will* be a source of strength, but if added improperly it may be a source of weakness, as we will endeavor to show.

Suppose, for instance, the beam has the section shown in Fig. 1, the rib being quite small and narrow compared with the main body of the section and the material being homogeneous. We would expect the rib to crack under only a slight deflection of the beam. If there was no rib, the beam with the rectangular section (2" x 5") would stand a greater deflection, under a greater load. The beam without the rib would be the stronger of the two.

Since the strength of a beam-member is proportional to the "modulus of its section" the question may be asked: Can the section be such that a reduction in its area will result in a section with a greater modulus?

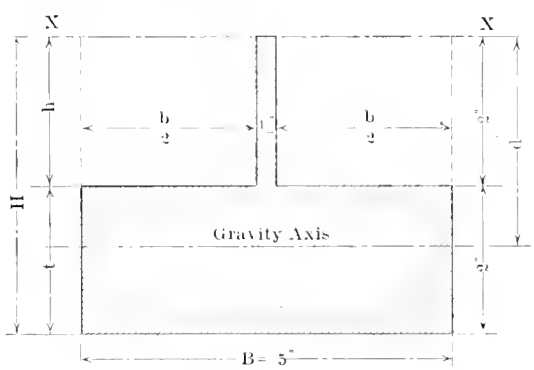


Fig. 1

We will compare the modulus of the 2 x 5 inch rectangular section, with that of the section shown in Fig. 1.

For the rectangular section the modulus is

$$Z = \tfrac{1}{6}\,B\,t^2 = \tfrac{1}{6} \times 5 \times (2)^2 = 3\tfrac{1}{3}.$$

In which B = breadth of section = 5 inches
t = thickness = 2 inches

To get the modulus of the ribbed section we will proceed as follows, referring to Fig. 1 for the letters and the dimensions used:

The moment of inertia about the axis XX, Fig. 1, is

$$I_x = \tfrac{1}{3}\,B\,H^3 - \tfrac{1}{3}\,b\,h^3.$$
$$= \tfrac{1}{3} \times 5 \times (4)^3 - \tfrac{1}{3} \times (4\tfrac{3}{4}) \times (2)^3 = 94\ 00.$$

The area of the section is

$$A = B\,H - b\,h = (5 \times 4) - (4\tfrac{3}{4} \times 2) = 10\tfrac{1}{2} \text{ sq, in.}$$

The distance of the gravity axis from the axis $X\,X$ is

$$d = \tfrac{1}{2}\,(B\,H^2 - b\,h^2) \div (B\,H - b\,h).$$
$$= \tfrac{1}{2}\,(5 \times 4^2 - 4\tfrac{3}{4} \times 2^2) \div (5 \times 4 - 4\tfrac{3}{4} \times 2) = 2.90.$$

The moment of inertia about the gravity axis is

$$I = I_x - A\,d^2.$$
$$= 94 - (10\tfrac{1}{2} \times 2.9^2) = 5\ 7.$$

The least modulus of the section is

$$Z = I / d = 5.7 / 2.9 = 1\ 96.$$

The ribbed section would therefore be only 1.96/3.33, or less than 6/10, as strong as the section without the rib. A crack through the rib would make the beam 10/6 stronger to resist further fracture.

From the foregoing it appears that there are two breaking strengths for a beam-member with a ribbed section, in which the rib is a source of weakness. At a certain load the rib will begin to crack. This may be called the "*initial*" breaking load. It will take a greater load to cause complete fracture. This may be called the "*final*," or "*ultimate*," breaking load.

In Fig. 2 is given a curve which shows the relation between the modulus of section and the depth of the rib, for the T-section which is shown in the same figure. It will be seen that the modulus of the T-section is less than that of the simple plate, 8 x 1½ inches, unless the 1-inch rib has a greater depth (h) than 1 8/10 inch. The data for the curve are given in the following table:

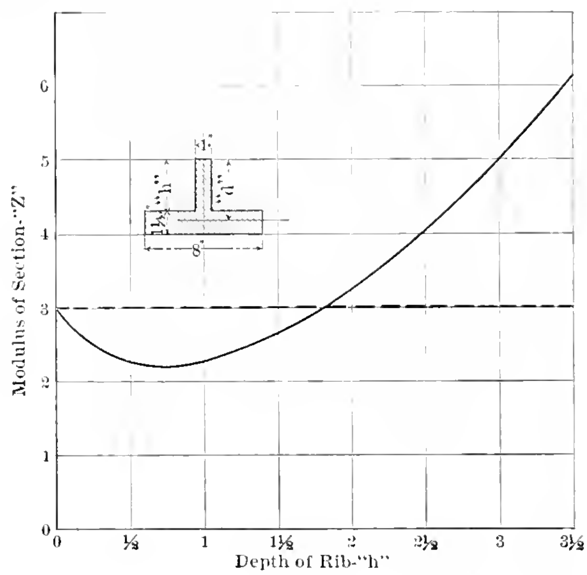


Fig. 2.

h	0	½	1	1½	2	2½	3	3½
I	2.25	2.75	3.77	5.52	8.16	11.78	16.65	22.75
d	.75	1.21	1.65	2.08	2.50	2.90	3.30	3.68
Z	3.00	2.27	2.29	2.65	3.26	4.06	5.05	6.17

In the foregoing we have spoken only of the strength of a beam as affected by the rib. There is also the consideration of the *stiffness*. This will always be increased by the addition of a rib. The stiffness is proportional to the moment of inertia of the section, which will always be made greater by increasing the area of the section in any way.

* * *

The trial electric locomotive built by the American Locomotive Co. in conjunction with the General Electric Co. of Schenectady, N. Y., has been tried on a trial track near Schenectady, and the results seem to indicate that the New York Central's terminal problem, so far as a motor is concerned, is solved. For years the New York Central and New York, New Haven and Hartford Railway has labored under great difficulties in handling the traffic at the New York terminal. The smoke and gases which accumulate in the Park Avenue tunnel make this section highly disagreeable to passengers and a menace to their safety, for there are periods when practically no other system of signals can be depended on but torpedoes. The terminal improvement plans require the use of electric motors and exclude the steam locomotive entirely in the New York City terminal proper. The specifications require electric locomotives capable of hauling trains weighing 435 tons, to make a run of 34 miles (Grand Central Station to Croton) in 44 minutes without stopping, and with only one hour lay over to be able to keep up this service continuously. The trials of the first locomotive built seem to indicate that its speed and acceleration are such as to easily accomplish the trip in the required time. With a 500-ton train, an acceleration of six-tenths of a mile per minute can be acquired from a dead stop, which means that one minute after the power is applied the train will be running at the rate of nearly 30 miles per hour. The trial track at Schenectady is only four miles long, so that it was not possible to make prolonged tests of speed acceleration, but speeds of 60 to 75 miles per hour were made while hauling a 500-ton train.

IMPROVEMENT ALL ALONG THE LINE.

THE MOST COMPREHENSIVE REPORT OF THE MACHINERY TRADE EVER PUBLISHED.

The machinery trade is unanimous in the opinion that business prospects are good for 1905, and that the improvement has already set in. To help manufacturers in forecasting the immediate future of the machinery trade a letter containing the following questions was sent to several hundred firms:

1. Has there been any improvement in your business lately?

2. Have we reached the bottom of the present business depression; if not, do you anticipate an early improvement in general business conditions?

3. What are the business prospects for 1905 in your line?

The substance of the replies received is given below in condensed form and almost without exception they express the belief in an upward trend in business conditions:

ACME MACHINERY CO.: Some improvement within 30 days, indications are for early improvement in business conditions. Inquiries are much more numerous than for some time past. Prospects encouraging.

AJAX MFG. CO.: Quite a little improvement lately, and business prospects seem very bright for 1905.

AKRON ELECTRICAL MFG. CO.: Radical change during the past six weeks. Booked more orders than previous four months combined. Have orders enough to keep factory running at fullest capacity for at least four months.

ALBRO-CLEM ELEVATOR CO.: Business improved wonderfully last two or three months; been very busy for that period. Think business prospects 1905 very bright.

T. R. ALMOND: Decided improvement in business latter part of September and October, which is continuing. Present volume of business equals that of same time one year ago. Have unquestionably passed the low point, and prospects for 1905 ought to be as good as any year that manufacturing industries of this kind have seen.

AMERICAN BALL CO.: Have had all the business in balls and ball bearings during past year that we could handle; sufficient orders on hand to keep us busy for the next two months or more. Outlook for 1905 very encouraging.

AMERICAN GAS FURNACE CO.: The business of this company has suffered no depression whatever. Facilities for turning out work have not increased as rapidly as demands for our product. Are therefore hardly in position to throw light upon the question. Overloaded with orders.

AMERICAN MCHE. & MFG. CO.: The present with us is not so busy as short time ago. Large amount of work in sight and we think we have reached the bottom and that from now on the tendency will be upward.

AMERICAN ROLLER BEARING CO.: Business exceedingly slack past summer and fall, but since election have noticed a remarkable change; have closed a number of deals, and prospects excellent.

AMERICAN TAP & DIE CO.: Our business has doubled during the past year. Have not noted any particular depression, possibly owing to increased energies made to secure larger business, which we have done. Anticipate a good business for 1905.

AMERICAN TOOL & MCHE. CO.: There has been practically no improvement in our business lately. Think we have reached the bottom of present business depression and anticipate early improvement in business conditions. Prospects for 1905 in our line we think are very good.

AMERICAN TOOL WORKS CO.: Business within last three months shown remarkable improvement. Are putting on additional men almost daily; also some additional equipment. Our opinion healthy and continued improvement has set in; anticipate enough business in 1905 to keep plant fully employed.

AMERICAN WATCH TOOL CO.: Our business gradually improving from year to year, and this year has been no exception. We have felt no business depression. Employed our usual complement of machinists all through the season, and our business compared favorably with that of 1903. No reason to expect anything less for 1905, but look for the same steady, conservative improvement.

ARGUTO OILLESS BEARING CO.: Business materially increased of late; not only due to healthier condition of trade in general, but also from effective advertising in MACHINERY. As "Arguto" is used in various industries we judge from increased orders and number of inquiries that business depression is now a thing of the past. Our prospects for 1905 are very bright.

ATLAS MCHE. CO.: Marked improvement in our business lately. Our foreign trade growing larger as well as our home trade. Can only conjecture as to whether we have reached bottom of present depression but confident that now the election is over every one can devote his time to business instead of to politics. Prospects much better for 1905 than for the present year.

AUBURN BALL BEARING CO.: The last month have had marked increase in our inquiries, and think next two months business will pick up very materially. Unable to fathom depression in metal trades which has continued since August, 1903, but from increased number of inquiries think that in next two or three months business in the metal trades will have big improvement.

AUTOMATIC MCHE. CO.: Have three distinct lines of business, i. e., marine work; original automatic wire-forming and experimental machinery, and automatic threading lathes. Marine trade has been good and is rapidly increasing; special work is and has been constant for past year; automatic threading lathe output depends upon the machine-tool trade, and this is steadily increasing. We notice foreign demand leads domestic, but home inquiries are more brisk and we confidently look for a uniform advance all along the three lines. We certainly believe we are at the ebb of the business depression.

HENRY CAREY BAIRD & CO.: We think decidedly we have reached bottom of depression; we believe prospects are very good.

BAIRD MCHY. CO.: Business has improved quite a little in past thirty days; inquiries very encouraging, and point, we think, to a lively business in the near future. Feel that late business depression was buried on Nov. 8th.

BAKER BROS.: Our machine tool business very quiet for last three months, but think there has been improvement since first of month and from present outlook are expecting good trade after first of year, believing that business conditions fully warrant such a hope.

BANTAM MFG. CO.: Improvement in business; prospect for coming year: our old time boom. The bottom was reached last August.

EDWIN E. BARTLETT: 1. Yes, decidedly. 2. We do. 3. Good.

WM. BARKER & CO.: Great improvement; expect to have a great deal more to do shortly; prospects for 1905 very favorable.

BAY STATE STAMPING CO.: Our business gradually improving since last January, and if there has been a depression in other lines it has not affected us in any way. Business prospects for 1905 seem to be very bright.

THE BAY STATE TAP & DIE CO.: Past two months decided improvement in our business.

BAYLDON MCHY. & TOOL CO.: There has been no increase in sales in our business lately, but inquiries vastly increased within last two weeks. Believe bottom of business depression was reached during the early summer months, and look for steady improvement.

H. G. BARR: Seems to be an improvement. Sales are on the increase. Think that machine tool business has reached bottom of present depression and that heavier tools will advance more noticeably than light tools for a little time. Expect twice the business for 1905 than in 1904.

BAUSH MCHE. TOOL CO.: 1. There has been an improvement in our business lately. 2. yes. 3. we would give a good box of cigars to know.

BEAMAN & SMITH CO.: Think indications are favorable for an improvement; think business prospects are better than they were a year ago.

BEAUDRY & CO.: Marked improvement in orders and tone of inquiries, bottom of depression we consider well past, and look for steady improvement in business conditions. Prospects for 1905 most promising.

BECKER BRAINARD MILLING MCHE. CO.: Quite a little improvement in conditions last two months. Believe bottom has been reached; are anticipating early improvement; do not look for much before new year. Believe prospects for 1905 good in machine tool business.

BELDEN MCHY. CO.: Improvement of late, and we feel very optimistic concerning outlook for coming year.

DAVID BELL ENG'G WORKS.: Decided improvement in orders; believe that the prospects for next year are fairly bright, although we do not look for a banner year until 1906.

BENSKIN MFG. CO.: Improvement in our business recently; certainly have reached bottom of present business depression. We have entire confidence in an early improvement in general business conditions, and the prospects for 1905 as they appear to us, are all that could be desired.

BERTSCH & CO.: Since election business steadily increased. Believe worst of business depression passed, and outlook for 1905 very good.

CHARLES H. BESLY & CO.: Marked improvement in our business lately. Our customers seem to be starting on a period of increasing activity. Business prospects for 1905 are good.

BETHLEHEM FDY. & MCHY. CO.: Our business has shown decided improvement lately, and believe depression is rapidly passing to buoyancy. Every indication of improvement in general business, and prospects for 1905 very encouraging.

H. BICKFORD & CO.: Outlook for better conditions in 1905 is excellent.

BICKFORD DRILL & TOOL CO.: Improvement last six weeks. Believe will continue, although do not anticipate marked increase until after first of year. Foreign trade also improving and 1905 should develop into a good year for us.

BIGNALL & KEELER MFG. CO.: Inquiries strong and their general tone gives the impression that people intend to buy in the near future. Think there is already an improvement in business conditions.

HUGO BILGRAM: My opinion is that recovery will be slow, as usual after depressions.

BILLINGS & SPENCER CO.: Believe we have reached bottom and indications are we are going to experience improvement in business from now on. Prospects very encouraging. Increased inquiries for products in our line.

BINSSE MCHE. CO.: Marked improvement in our business since September. Bottom of depression passed. Look for not merely an early improvement but for a demand for prompt delivery which will disappoint a great many. Foreign trade shows improvement.

BORDEN CO.: 1. consider [illegible] improvement lately. 2. we [illegible] best.

BOYNTON & P[illegible]: [illegible] early [illegible] increase. Look forward to 1905 as a good business year [illegible]

BRADFORD MCHE. TOOL CO.: Decided improvement [illegible] lately; now operating [illegible] steps [illegible] trade at home improving every day. Prospects [illegible] bright.

B. H. BROWN & CO.: Decided improvement [illegible] six weeks or two months. Think [illegible] reached [illegible] depression and anticipate [illegible] business [illegible] after middle of January.

BROWN & SHARPE MFG. CO.: [illegible] somewhat [illegible] tions will continue [illegible] Prospects [illegible] 1905 in our line are favorable.

BROWN HOISTING MCHY. CO.: [illegible] 2. and [illegible] look for big improvement immediately.

BROWN & ZEIGMAN MCHY. CO.: [illegible] in last forty days [illegible] business that has been hanging fire for six or eight months, and the business is from some of [illegible] corporations, indicating that the big people are once more going into the market. We feel bottom has been reached and are on a [illegible] starting [illegible]

recover from general depression felt more in Pittsburg territory than in any other part of country.

BUILDERS' IRON FOUNDRY: Slight improvement in our grinding and polishing machinery line. Orders larger and more frequent; more inquiries. Looking for early improvement, possibly not until first of year, but believe in 1905 there will be a decided improvement along all lines of manufacture.

BUTTERFIELD & CO.: Business improved very much since middle of year; believe bottom has been reached; prospects for 1905 are excellent.

ROYAL E. BURNHAM: Business was very good up to the first of September, when there was a marked falling off. Since settlement of political conditions, there are signs that business will return to its normal conditions.

JOHN T. BURR & SONS: Outlook for immediate future of our business very bright indeed. Our business for ten months this year more than equaled sales for whole of last year; numerous inquiries covering everything we manufacture.

BUTLER CHUCK CO.: Improvement in chuck demand recently and an undercurrent of inquiry which indicates that tide has already turned; strong grounds for expecting that future will not withhold its harvest from those who diligently plant.

CARBORUNDUM CO.: Some improvement in business lately, and from general outlook in this locality, look for steady improvement from now on.

CARPENTER TAP & DIE CO.: Fall trade shows great improvement, and indicates a good year for 1905.

CARR BROS: Our business has shown steady improvement the last four months, with good prospects for the future.

CARTER & HAKES MCHE. CO.: Business very even and steady during the whole of last year, and recently no marked change. Prospects of plenty of work for the next year.

CHAMBERSBURG ENG'G CO.: Decided improvement in our line of business lately.

CHANDLER PLANER CO.: Large amount of business in sight, but that may be due to the fact that we are offering something out of the usual course of machine tools. We are, however, in the market as purchasers, and the fact that business is reviving is evident from increased difficulty in getting promise of deliveries of certain tools that a few months ago were seeking purchasers.

CHATTANOOGA MCHY. CO.: 1. Yes. 2. We do. 3. Last six months our business improved materially; look for next year to be most prosperous we have had.

CINCINNATI MACHINE TOOL CO.: Much better feeling in machine tool market; some orders placed which have been hanging fire very long. Anticipate early improvement. Indications for next year are for good business.

CINCINNATI PLANER CO.: Considerable improvement during past sixty days. Believe are now starting on period of good healthy business. Anticipate increase of fully 50 per cent. for 1905. Believe people are gradually having their confidence restored.

CINCINNATI PUNCH & SHEAR CO.: Business was unusually quiet until about Oct. 1st, since which time decided improvement, not only in inquiries but in substantial orders. We are quoting as many probably now as during the last few rush years. Believe will be busy the rest of this year and busier next.

CINCINNATI SHAPER CO.: Very decided improvement in business conditions lately. No doubt bottom of the present business depression has been reached, and we anticipate the year 1905 to be a banner one.

JAS. CLARK, JR., & CO.: Marked improvement in our manufacturing business of late; in fact, we have as much as we can possibly do for several months to come with our present capacity. Believe business will gradually improve until in the very near future we believe that business will be on a boom.

CLEVELAND ATOMATIC MCHE. CO.: Last four months our business has been extremely good. Operating factory to fullest capacity, and hardly able to keep up with orders. Hardly think we have at the present time a business depression. True, in a number of branches, we are not as busy as one year ago, but nevertheless general business of country is in fairly good condition. Prospects in this country at present time exceedingly bright, and believe that after holidays business will improve rapidly.

CLEVELAND CAP SCREW CO.: Material improvement in trade last two or three months: look for a continuance, or even further improvement of this condition.

CLEVELAND CRANE & CAR CO.: Business has improved materially; that for last three months much better than for eight mouths preceding. Believe bottom has been reached. Do not, however, anticipate much improvement until early next spring, after which we believe business will be as good as ever.

CLEVELAND PNEUMATIC TOOL CO.: Do not anticipate much revival until April, 1905; believe things will then get into pretty good swing and go along for several years in elegant shape.

CLEVELAND TWIST DRILL CO.: Business during past year considerably less than during three previous years; some improvement during the past sixty days. Think bottom reached, and every prospect for fine business for 1905.

CLING-SURFACE CO.: Business steadily improving during all fall months. Believe will continue to improve and indications point to prosperous year during 1905.

R. M. CLOUGH: See little change as yet. Expect better times.

COLUMBUS MCHE. CO.: Look for no great improvement until after first of year. Business very fair past few months and we expect it to continue; with spring there will be real good buying and everything will move along in good healthy way.

CROWE METAL MFG. CO.: Our business a new one, and growing steadily. Pick-up lately indicates we are on up grade again.

CURTIN-HEBERT MFG. CO.: Slight improvement in our business of late.

CURTIS & CURTIS CO.: Improvement since last June. While still behind the booming times of two years ago, certainly improving, and we look for several years of good business to come.

CURTIS & CO. MFG. CO.: Do not anticipate further decline in business, but a somewhat increased demand for our products.

CUSHMAN CHUCK CO.: Great increase of activity among our own customers and for many weeks inquiries and orders have been coming in more freely than for several months; indicates an improvement in the machinery trade generally and also a busy season for us.

W. P. DAVIS MCHE. CO.: Improvement in business within last two months. Believe prospect for business in 1905 good. In manufacturing of machine tools there will not be the demand from the dealers we have had in the past, as we believe their policy will be to buy only for their present requirements, as nearly all have been carrying very heavy stocks. Believe general demand all over the country will be good.

DERRY-COLLARD CO.: Improvement in our business during the past month. We feel there is upward tendency in business; anticipate a good trade during coming months; prospects for 1905 better than for past two years.

DESMOND-STEPHAN MFG. CO.: Are new in the business but business satisfactory and constantly increasing.

DETROIT TWIST DRILL CO.: Improvement. Certainly all the conditions are now favorable.

DIAMOND SAW & STAMPING WORKS: Output for September largest in history of our business. Believe we can look forward to a steady and marked improvement, and that next four years will show no decrease in the volume of trade as compared with the past term of prosperity.

DODGE & DAY: Our Mr. Day, returned from extensive trip through west, reports indications are there will be very material improvement in business shortly.

DRAPER MCHE. CO.: Marked improvement in business during last month; bottom of depression reached; from now on business will steadily become better. From orders placed and inquiries received, we anticipate a good business in 1905.

DRESES MCHE. TOOL CO.: Since October, business improved considerably; outlook very good; think the prospects for 1905 very promising.

EASTERN MCHY. CO.: Business shows improvement past two months. Has been good past three or four years.

EATON, COLE & BURNHAM CO.: Considerable improvement of late; good prospect both for this year and for 1905.

ELWELL-PARKER ELECTRIC CO.: Distinct improvement lately; do not hesitate to say we have considerably passed bottom of depression. As to 1905, are sure it will be a first-class year for every one.

ERIE ENGINE WORKS: Improvement in business conditions of late; anticipating further and early improvements in general business, and hope it will be realized.

ERIE FDY. CO.: Very decided improvement in our business; very hopeful for a good year in 1905.

EXCELSIOR TOOL & MCHE. CO.: Business brightened up lately; feel encouraged to believe business will constantly improve, and that prospects for 1905 are bright.

FANEUIL WATCH TOOL CO.: Did not feel recent depression very much; looks as though we are going to have an extra big year.

FAY & SCOTT: Our business very good up to last July; since, rather quiet; our prospects are bright for 1905.

FENN SADLER MCHE. CO.: Business improved steadily. Prospects for 1905 look very bright to us.

FERRACUTE MCHE CO.: Business prospects for coming year seem good. Have had all the work we could do during the past year. Judging by number of orders we expect to have enough to do in our new fire-proof works.

FITCHBURG MCHE. WORKS: Look forward to good business for ensuing year.

FLATHER & CO., INC.: Decided improvement; busy as can be; large number orders on hand and are receiving more inquiries.

MARK FLATHER PLANER CO.: Have been able to close a few very nice orders at excellent prices. It would appear that business will begin to come in shortly after the opening of new year, probably about February or March; from that time on we anticipate as much or more business than able to take care of for next three or four years.

FOOS GAS ENGINE CO.: For the last six months have had more business than could handle, with every indication of its continuing.

FOOTE, BURT & CO.: Business seems to have opened up in better shape than during October. All signs that we will very speedily have a resumption of good business. Think prospects for 1905 extremely good in our own line and in all machine tool lines.

FOSDICK MCHE. TOOL CO.: Business improved much since first October; now running full time and look forward to good year. Believe there will be fair and steady demand for machine tools.

FOX MCHE. CO.: Inquiries and orders coming in much better; prospects for good fall and winter business very bright.

WILLIAM E. GANG CO.: 1. Yes. 2. Yes. 3. Prospects for 1905 in our line, good.

WM. GANSCHOW: From large number of inquiries both from local concerns and also out of town, business must be commencing to pick up again. No reason on earth why business in 1905 should not be a good deal better than the last year.

WM. GARDAM & SON: Business very even during past year; from number of inquiries prosperous year for 1905 certainly indicated.

GENERAL PNEUMATIC TOOL CO.: Last two and a half months marked increase in amount of business; confident that there will be a steady improvement.

GEOMETRIC DRILL CO.: Marked improvement past few weeks both in inquiries and orders; feel very much encouraged; prospects for 1905 in our line very bright indeed.

GOODELL-PRATT CO.: Believe outlook as regards small tool trade very encouraging; believe—and not without having carefully considered the situation—that 1905 will be biggest year small-tool manufacturers ever enjoyed. Understand us, we do not presume to comment upon conditions existing in the machinery line, for that is foreign to our business.

GIANT MOTOR CO.: Business good for last two months, with best prospects for 1905.

GLASGOW IRON CO.: Think business prospects for 1905 are very good.

GLOBE MCHE. & STAMPING CO.: Sales for 1903 50 per cent. higher than in 1902, and for 1904, fiscal year ending October 1st, 33 1-3 per cent. higher than for the previous year. Now have sufficient business to run six or eight months. Prospect for prosperous year 1905 bright.

GODDARD MCHE. CO.: Business improved somewhat last few weeks. Believe situation will continue to improve; look for much better business in 1905.

GOULD & EBERHARDT: Quite some business right along, anticipate gradual improvement with good steady demand during the coming year.

GRAY & PRIOR MCHE CO.: Glad to say have not felt depression; prospects in our lines for coming year excellent.

GREAVES, KLUSMAN & CO.: Decided improvement in business lately; prospects for 1905 very good.

GUARANTEE ELECTRIC CO.: Surprising increase in business since election; think that for the next year or two it will be steadily on the increase.

HAMILTON MCHE. TOOL CO.: 1. Yes. 2. Under impression we have seen worst of present business conditions. 3. Everything indicates we will have an average year.

HAMMACHER, SCHLEMMER & CO.: 1. Yes—barring slight set-back due to our moving. Believe there will be a healthy, conservative period for some time to come.

HARRISON SAFETY BOILER WORKS: Past sixty days business conditions steady improvement; anticipate full resumption in practically all lines by commencement of new year.

HAYES FILE CO.: 1. Yes. 2. We think we have. 3. We think the outlook very bright.

HAZELTON & DONALD MCHE. CO.: Are of opinion tendency will be to go a little slow for a while, but prospects for 1905 exceedingly favorable.

HEALD MCHE. CO.: Very busy, indeed, ever since we moved our plant to Worcester. Believe that last five or six weeks decided improvement in inquiries, and orders that will be even more pronounced after the first of the year.

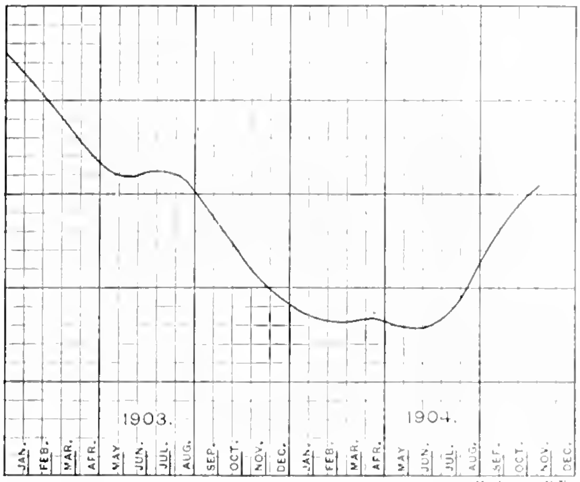
HENDEY MCHE. CO.: Substantial increase past two or three months; have a large number of unfilled orders. Anticipate very good business coming year.

HESS-BRIGHT MFG. CO.: Our business continually improving. Prospects for 1905 very satisfactory.

GEORGE WILLIAM HOFFMAN: Business lately very good until last week or so; depression, I presume, due to election; expect my sales for 1905 to almost double those of previous years.

HILL, CLARKE & CO., Boston, Mass.: Anticipate a fair amount of business during greater part of next year.

HILL, CLARKE & CO., Chicago, Ill.: Your question can be very nicely answered by little curve inclosed herewith; shows that business dropped off about January, 1903, reached its lowest notch in May and June, and



since then has been considerably on increase, and according to outlook ought to be back to normal condition by next spring. What we mean by "normal" would be a condition to compare very close to year 1902.

HISEY-WOLF MCHE. CO.: Think prospects for 1905 are first-class in all lines; look for good healthy business, from January 1st particularly.

HOGGSON & PETTIS MFG. CO.: Business about the same past month or so; look for increase soon, with prospects good for 1905.

B. P. HORTON: Very quiet, but looking forward to steady increase. See no reason why 1905 should not be a record breaker.

E. HORTON & SON CO.: Some improvement of late; anticipating a still further improvement in the near future. Prospects for 1905 good.

E. F. HOUGHTON & CO.: 1. Yes. 2. Running to full capacity. 3. Elegant.

HOWARD IRON WORKS: Have noticed improvement in our business lately. Prospects for 1905 good.

HURWOOD MFG. CO., INC.: Prospects for doing a good business in 1905 rather better than fair.

HYATT ROLLER BEARING CO.: Have noted a general improvement in the machinery lines past four or five months. From indications are going to have increased business in all lines for at least two years to come. Prospects for 1905 are particularly bright in our line.

IDEAL MFG. CO.: Improvement in situation during last two months; inclined to think will be an improvement in business conditions early in 1905.

INTERNATIONAL CORRESPONDENCE SCHOOLS: Our business has annually shown large increase since origin, in 1891. Believe that coming year will be best the Schools ever experienced.

INTERNATIONAL POWER VEHICLE CO.: Improvement very perceptible in our case.

INTERNATIONAL SPECIALTY CO.: Business only started about six months ago; fair demand for our emery wheel dresser; anticipate a good business next year.

IVES MFG. CORPORATION: 1. Yes. 2. Passed bottom of depression. 3. Prospects for 1905 of the brightest.

JACOBSON MCHE. MFG. CO.: Business shows marked advance each week. Think business will be at least up to normal standard in short time if not considerably above.

D. O. JAMES: From present indications future outlook very cheerful.

R. A. KELLY CO.: Look for better trade during 1905 than we have enjoyed for some time past.

KEMPSMITH MFG. CO.: Business in our line picking up nicely; feel that depression has reached its bottom, at least we hope so.

KENDRICK & DAVIS: 1. Fully equal to last year. 2. Yes. 3. Very good.

KEYSTONE DROP FORGE WORKS: Improvement lately; tone, in general, seems to indicate continued improvement. Prospects for 1905 encouraging.

KILBOURNE & JACOBS MFG. CO.: Very decided improvement during the last two months. Prospects for 1905 excellent.

KING MCHE. TOOL CO.: Number of inquiries increasing; think there will be a temporary boom in our line caused by placing of orders by such concerns as have held off until last minute; anticipate good average year in 1905.

LANCASTER PEERLESS EMERY WHEEL CO.: Feel much encouraged; have had several very nice orders since election.

MAIN BELTING CO.: We are right busy; think prospects upward and first-class.

EDW. LINDMUELLER: Decided improvement lately; think have reached low ebb of business depression, and are on the rise. For 1905 prospects very encouraging; anticipate busy season.

LINK-BELT ENGINEERING CO.: Orders since the 8th noticeably more numerous than during period immediately preceding that date. Look for material improvement in business conditions and a [illegible] tide.

LODGE & SHIPLEY MCHE. TOOL CO.: Improvement in [illegible] to 90 days. Business prospects for the future very [illegible]

LUCAS MACHINE TOOL CO.: 1. Evidences of substant[illegible] ment. 2. Think we are well on the road to bett[illegible] Favorable.

WALTER MACLEOD & CO.: Have every confidence that [illegible] will show great improvement over the present one. [illegible] last six months than six months previous. Railroads and [illegible] users buying more generously; look for even better returns in [illegible] future.

F. B. MCCROSKY MFG. CO.: Decided improvement in demand [illegible] our product, beginning early part of October. Believe bottom of [illegible] ent depression was reached some time ago. Prospects for 1905 [illegible] cellent.

MCDOWELL, STOCKER & CO.: Inquiry getting some better. Bel[illegible] there will be early improvement in general business conditions, [illegible] not much before first of coming year.

MANNING, MAXWELL & MOORE: Marked improvement in the ma[illegible] chinery business this month. Believe have reached bottom present bus[illegible] iness depression; anticipate good general business, without marked increase in prices until demand is considerably larger, when we think prices will advance. That, of course, will rest largely with the manu[illegible] facturers, and is a matter they will control, according to amount of business they have in proportion to their capacity. Think prospects in our line for 1905 very good, though do not look for any great boom.

MANVILLE BROS. CO.: Great improvement recently, and think [illegible] sales will be very much increased during coming months.

MAYER & CO.: Tendency of improvement; more inquiries coming [illegible] As for 1905, think it will be beginning of era of prosperity and good feeling.

MEISEL PRESS & MFG. CO.: 1. Yes. 2. Yes. 3. Very good.

OTT. MERGENTHALER & CO.: Some improvement, and we antic[illegible] more.

MERRELL MFG. CO.: Business not improved any as yet, but antici[illegible] pate general improvement in conditions. Prospects for 1905 very bright in our line.

MERRILL BROS.: More inquiries for machinery within last month than for six months previous. Our business no[illegible] depressed [illegible] anti[illegible] pate general improvement.

MERRITT & CO.: Decided improvement in past sixty days; business has steadily grown during past three or four years.

MICHIGAN LUBRICATOR CO.: Decided improvement in trade condi[illegible] tions; anticipate a boom year in 1905.

AUGUST MIETZ: Some improvement in our business lately; expect early improvement in conditions. Prospects for 1905 in our line very good.

MILLER'S FALLS CO.: Very perceptible improvement commencing about October 1st. Conditions favorable for continued increase in volume of business.

MILWAUKEE TOOL CO.: Outlook for 1905 not discouraging for beginning of year; the latter part will be a commendable season, comparatively speaking.

MITTS & MERRILL: Considerable improvement during past month; business for two or three preceding months comparatively light. Look for steady improvement in our business during next year.

MINER & PECK MFG. CO.: Orders now coming in fairly well; quite an increase in inquiries.

MONTGOMERY CO.: Considerable improvement during last two months. Believe winter trade is going to be fairly good, and by spring conditions will be excellent.

MORSE CHAIN CO.: Our orders for drives for machine tools less than usual, but for chain power transmission increasing very rapidly, and have been during last three months.

C. A. MOSSO: My business increased more than double in last year. Am not looking for a boom, but good steady business, with healthy increase for some time to come. Prospects for 1905 were never better.

FRANK MOSSBERG CO.: Steady increase in our business during October; prospects at present writing for 1905 better, and we look for a good business.

MUELLER MCHE. TOOL CO.: Have of late noticed improvement in machinery business. Prospects for 1905 in our line very good.

NATIONAL MCHE. CO.: Have had good year. Outlook very good for 1905.

NATIONAL SEPARATOR & MCHE. CO.: Very good business; looking for amount of business for 1905.

NEW ERA MFG. CO.: The present year, as a whole, will be one of the best in the history of our company, and prospects for 1905 very flattering in our line.

NEW ENGLAND ROLLER GRATE CO.: Prospects for coming year very bright. Our business on steam specialties very good throughout the year.

NEWTON MACHINE TOOL WKS.: Steady increase in our business last two or three months, especially within the last week or so. Do not anticipate any boom; we think by first of year there will be a good steady business, especially so with railroad companies.

NILES-BEMENT-POND CO.: Business with us very much improved; prospects for coming year we consider most promising.

NORTHERN ELECTRICAL MFG. CO.: Marked improvement in inquiries and orders since September. Business at the present time very satisfactory. The prospects for 1905 seem good.

NORTHERN ENG'G WORKS: Quite an improvement both in inq[illegible] and orders placed. Anticipate further improvement in business [illegible] three or four months.

NORTHWESTERN MFG. CO.: Business steadily increased for [illegible] three months. Believe bottom of depression was reached [illegible] months ago and the prospects for next year are [illegible] demand on the increase all the while for high grade apparatus [illegible] as we make.

NORTON EMERY WHEEL CO.: Business very good [illegible] Prospects splendid.

OHIO MCHE. TOOL CO.: Some improvement recently, and look for it to continue. Are looking for a much better business in 1905.

L. H. OLMSTED: Decided improvement in demand for goods during past six weeks; continues at present.

OLIVER MCHY. CO.: Material improvement last three or four months. Large number inquiries, which will undoubtedly lead to future business. Anticipate 1905 being a record breaker.

ONEIDA STEEL PULLEY CO.: Been making all we could and unable to fill our orders. Have not realized there was any depression.

J. L. OSGOOD: Find business in machinery line in this section improved since August. Inquiries increasing and orders coming in for machinery. Indications are 1905 will prove a prosperous year to the machinery trade.

Charles Parker Co. Certainly a decided improvement in business last six weeks or two months. Reached the bottom on business depression. Prospects for 1905 in our line of goods is bright.

W. M. Pattison Mchy. Co.: Cannot find great improvement in business, although last month showed a little. Better prospects for 1905, though we do not consider there will be any rush in the machine tool line.

Pedrick-Smith Co.: Look forward to prosperous year. Mail very encouraging, containing many inquiries; very busy; have started night shift, to get out the orders.

Perkins Mchb. Co.: Improvement of late, starting about 45 days ago; business on the increase, obliged last week to run night and day to keep up with orders.

Perry Time Stamp Co.: 1. Yes. 2. Believe have reached bottom of present business depression. 3. Business prospects for 1905 in our line excellent.

Philadelphia Pneumatic Tool Co.: Sales for October far exceeded those of preceding month. Inquiries good, coming from all portions of country. Anticipate a very prosperous year for 1905.

Phillips Pressed Steel Pulley Works: Too new to have experienced business depression; we hear confidence expressed everywhere.

Phoenix Mfg. Co.: More calls at present; think tide has turned, and good business will be with us.

Phosphor-Bronze Smelting Co., Ltd.: Business shows slight improvement of late.

Pike Mfg. Co.: Confident business will pick up, and are anticipating large demand for our goods for the next six months.

L. W. Pond Mche. & Fdy. Co.: Improvement; numerous inquiries; feel prospects for 1905 in our line very bright.

Potter & Johnston Mche. Co.: Past six or eight weeks domestic demand greatly increased; foreign sales equally satisfactory; present outlook for 1905 points to a banner year.

Power & Speed Controller Co.: Considerable improvement past two months and bottom of the business depression reached; upward tendency. Prospects for 1905 would seem good if present advance continues.

Pratt & Whitney Co.: No serious depression in our business during 1904

Prentice Bros. Co.: Business improved greatly within last three or four weeks.

Geo. G. Prentice & Co.: Consider that bottom of depression reached. Prospects very bright for 1905.

Prentiss Tool & Supply Co.: Our business has shown steady improvement since August 15th. Expect satisfactory business for 1905.

Queen City Mche. Tool Co.: Improvement in business conditions; the machine tool line has taken quite a jump in this vicinity. Look for era of good times.

A. D. Quint: Decided improvement in business, foreign and domestic, in past six weeks. Spring of 1905 will see everything on the boom once more.

Railway Appliances Co.: Marked improvement in our machinery business of late; feel tide has already turned. Prospects for 1905 show promise more business than any time for last eighteen months.

Rand Drill Co.: Prospects for business for 1905 good.

Ransom Mfg. Co.: Expect, from now on, business will be better; look for a banner year in 1905.

Francis Reed Co.: Indications seem to be good in my line for 1905.

Ridgway Mche. Tool Co.: Notice improvement; have booked sufficient orders within last week to give us work for nearly a year.

Robertson Mfg. Co., Inc.: Past month marked improvement; prospects for 1905 very good. Trade on our rapid cut saws especially bright.

Robbins & Myers Co.: Substantial improvement last few weeks over business a number of months preceding. Indications point to a very favorable year.

John M. Rogers Boat, Gauge & Drill Works: Decided improvement in the general business conditions.

Roth Bros. & Co.: Prospects in our line look very bright.

Rowbottom Mche. Co., Inc.: Had fair business right along; have every confidence 1905 bringing complete revival of good business.

Royersford Fdy. & Mche. Co.: Quite an improvement in our business within last two months. Anticipate a very general improvement in conditions. Our prospects for 1905 exceedingly bright.

Ruggles Coles Eng'g Co.: Very decided improvement last month. Look forward to large business the coming year.

Saginaw Mfg. Co.: Considerable improvement in our business of late; prospects for 1905 excellent.

Sawyer Tool Mfg. Co.: Present business very good; outlook for future bright.

Screw Cutting Co. of America: Believe we shall have all we can do in 1905.

Schellenbach & Radcliffe: We have all we can possibly get out with our capacity until January, 1905. Our prospects for next year very good indeed.

Scott & Sons: 1. Yes. 2. We have. 3. Good.

Sebastian Lathe Co.: Believe we are entering on another era of prosperity. Fully expecting a good demand for our tools for the coming year.

Skinner Chuck Co.: 1. Yes. 2. Yes 3. Very good.

Sloan & Chace Mfg. Co.: Very decided improvement lately; expect business will at least equal 1903 and will probably be much better.

J. T. Slocomb Co.: Expect satisfactory business during coming year.

Ernst G. Smith: Had an average amount of business, and feel confident business will greatly increase in 1905.

J. D. Smith Fdy. Supply Co.: Our business increased about 20 per cent. past two months; if present growth continues, will not be long before we are doing as much as we did last year.

J. E. Snyder: Business past few months rather quiet. Getting some foreign orders, but domestic trade slow. Will see a good fair business during 1905.

Speed Changing Pulley Co.: 1. Yes, 50 per cent. 2. Yes. 3 Splendid.

Sprague Electric Co.: Recent improvements; prospects 1905 in our line are exceedingly good

Springfield Mche. Tool Co.: Considerable improvement in our business commencing September first. Believe that a steady improvement in general business conditions has now set in. For 1905 a fair business to be expected.

Standard Eng'g Co.: Better inquiry noted in our line; sufficient amount of machine orders on hand to keep us busy for at least three months. Believe general conditions are on the mend.

Standard Roller Bearing Co.: Considerable increase in our orders lately; appears to us business for 1905 will be very heavy. Busy all the time; have just doubled size of our plant.

Standard Welding Co.: Business in this city has been good throughout; have full confidence in immediate future; are looking forward to nice business during entire year of 1905.

Stark Tool Co.: Bright outlook in the near future; inquiries coming in; several orders on hand.

Steel Ball Co.: Demand for our lubricators great; factory running to fullest capacity; our business growing rapidly, forced to add facilities.

Steffey Mfg. Co.: Number orders received this month considerable advance over those received corresponding month last year. Prospects very good for 1905.

John Steptoe Shaper Co.: Every reason to believe coming year will be a good one.

Sterling Emery Wheel Mfg. Co.: Quite a change the last week; believe business will improve from now on. Prospects for 1905 bright.

Stewart Heater Co.: Experienced no depression in business for past four or five years. Confident business will continue for 1905 as in past few years.

D. M. Steward Mfg. Co.: Our trade increased past sixty days more than 25 per cent.; little doubt of good business for some considerable time in the future.

Stockbridge Mch. Co.: Very marked improvement past two weeks, inquiries and orders. Several propositions "hanging fire" past year, been closed. Expect gradual picking-up in business generally.

Stoever Fdy. & Mfg. Co.: Feel we have reached bottom of present depression, and any change must be for the better.

H. T. Story: Past summer and fall received more orders than during any previous season. Prospects for 1905 are good.

Stover Engine Works: Feel thoroughly convinced have reached the bottom of depression; look forward to one of largest gasoline engine years we have yet experienced.

Stow Flexible Shaft Co.: Utterly unable to make forecast for the next year; the hope is that it may be better.

Stow Mfg. Co.: Early spring months showed best business we ever had. Decided falling off July, August and September; steady improvement in October which has continued up to date. Everything points to continuation of good business.

Stratton Bros.: Business past two months up to average for September and October; for past ten months decidedly ahead of first ten months of last year. Expect unusually large trade coming season.

A. Streit Mche. Co: Have more inquiries on hand than at any time before; look for a very good year.

Charles A. Strelinger Co.: Outlook both for immediate present and for the year to come exceedingly good.

C. E. Sutton Co.: Slight improvement in our business within the last thirty days. Do not anticipate improvement in general business conditions before spring of 1905.

Tabor Mfg. Co.: We look for a better year in 1905 than we have yet enjoyed.

Thiem & Co.: All of our business has been good last few years, although have noticed brisk improvement in business for past two months. Our prospects for 1905 very good.

Thomas & Lowe Mchy. Co.: Have experienced great improvement during past few weeks both as to inquiries and sales, which we consider healthy indication.

Three Rivers Tool Co.: Our business has grown steadily; believe there will soon be very decided improvement in general conditions; looking forward to large business for 1905.

Toledo Mche. & Tool Co.: Believe we are near end of business depression. See no reason why business should not assume its normal proportions.

Toronto Mche. Co.: Note greater volume of business last few weeks, believe business in general will settle down to normal conditions for coming year.

Transue & Williams Co.: Believe business prospects in 1905 in our line of work very bright.

Trump Bros. Mche. Co.: Quite busy in some of our lines on accumulated orders, but new business not coming in as freely as we should like, for the past sixty days.

W. W. & C. F. Tucker: 1. Yes. 2. This is the tendency. 3. Very bright.

Turner Brass Works: Frankly state we do not think as far as business is concerned there is any depression whatsoever. Our prospects for 1905 very bright indeed.

Turner, Vaughn & Taylor Co.: 1. Yes. 2. Think business will come steady and healthy.

H. B. Underwood & Co.: Fairly busy during the entire year; have not encountered business depression; have kept on our regular force of employes, and lately have taken on some new ones. Prospects for 1905 very encouraging.

Utica Drop Forge & Tool Co.: Business improved last two months. Outlook is bright.

Vandyck Churchill Co.: Are looking forward to good, steady, satisfactory amount of business during 1905.

Veeder Mfg. Co.: Have had a very prosperous year indeed and anticipate even a better one next year.

Von Wyck Mche. Tool Co.: We personally have experienced a decided improvement in last five weeks. Prospects for 1905 exceedingly bright.

Wallace Supply Co.: Not noticed any recent improvement; believe, however, bottom of the depression reached and prospects for 1905 are very good.

O. S. Walker & Co.: While we do not look for a boom, anticipate fairly good business for winter. Prospect for 1905 seems likely to be fully up to the average.

Edgar T. Ward & Sons: 1. Yes. 2. Improving all the time. 3. Good.

Washburn Shops: Improvement in business the past month. Are anticipating a good year.

Waterbury Mche. Co: Past month considerable improvement. Looking forward to good year's work for 1905.

Watson-Stillman Co.: Our business has received a decided impetus; quietest record in several years July and August; future conditions appear very satisfactory.

Webster & Perks Tool Co.: Do not believe we suffered as much as some; certainly anticipate steady improvement in general business conditions. Regard prospects for 1905 as most promising.

Wells Bros. Co.: Business last four weeks improved somewhat, yet not up to usual standard; indications point to rapid improvement after first of the year.

WESTCOTT CHUCK CO.: Prospects now excellent for continued and increased improvement.

WESTERN TOOL & MFG. CO.: Since the first of month enjoyed marked improvement in trade. Machinery dealers are beginning to stock up, which indicates that trade is picking up with them. Also improvement in our trade with railroads, a good sign of business conditions.

WHITCOMB MFG. CO.: Marked improvement in planer business last few weeks; think business during 1905 and 1906 will be of good volume.

WILEY & RUSSELL MFG. CO.: Haven't observed any great falling off in our business. Very good for this time of year.

WILLIAMS, BROWN & EARL: Business picking up; we have never struck bottom, as this year's business is ahead of last year's business. Looking for great business year.

WILLIAMS TOOL CO.: Trade is somewhat irregular, coming to us in spurts and then laying off for a time, but there seems to be a feeling that 1905 will be the beginning of another prosperous season, and trust it will prove so.

WILMARTH & MORMAN CO.: Shipments for September 10 per cent better than for August; October 10 per cent. better than September, yet neither month equal to corresponding month year ago; impression is general conditions better, with prospect of good year ahead.

WINDSOR MCHE. CO.: Our business improved somewhat last six weeks; anticipate early improvement over condition existing for the last year; believe our prospects for 1905 good.

WINKLEY CO.: Believe will be a material improvement coming year; are planning according to these ideas.

WOODWARD & POWELL PLANER CO.: Indications are we will have a fair trade this coming year.

C. C. WORMER MCHY. CO.: Feel that depression will be ended in near future, and that after January 1st general conditions will improve.

WORCESTER MCHE. SCREW CO.: From present outlook we expect to be very busy within next three months and with all the business we can possibly attend to.

W. C. YOUNG MFG. CO.: Improvement in business within last sixty days; do not anticipate anything like a boom during coming year; simply a good, healthy business.

* * *

THE NATIONAL MACHINE TOOL BUILDERS' CONVENTION.

The meeting of the National Machine Tool Builders' Association was held at the Hoffman House, New York, November 15 and 16. No action was taken at this meeting in regard to prices, although the subject was discussed in view of the advance in prices of materials entering into the construction of tools. The executive committee were empowered to call a special meeting of the Association to consider the matter further, if this should be deemed advisable before their next regular meeting. Another subject discussed was in regard to placing of large orders by dealers when tools are in good demand, with the possibility of cancellations when there is a drop in the market. It was thought best that no concerted action be taken in the matter, and resolutions were passed simply advocating that the placing of large stock be discouraged, each member, however, managing independently, according to his own personal interests.

In view of the differential tariffs that have been adopted by some foreign countries, particularly Russia, France and Canada, prejudicial to the importation of American machine tools, as a result of American duties on certain products imported from these countries, a committee was appointed to investigate the subject and report to the executive committee, so that a suitable plan of action could be outlined by them for the next meeting.

At the second afternoon session a step was taken which, it is hoped, may eventually lead to the adoption of standard specifications for motor equipments for machine tools. The session was opened by a paper by Fred A. Geier, of the Cincinnati Milling Machine Co. He contended that it would first be necessary to decide upon a standard speed range for variable-speed motors. In milling machine driving a speed range is required at the spindle of from 25 or 30 to 1. By using a motor with a $2\frac{1}{2}$ to 1 speed variation, and then applying double back gears to the machine, this range can be obtained without difficulty; and by using motors with shunt field control, such as are now supplied by electrical manufacturers generally, plenty of speeds can be obtained between gear speeds. The Ward Leonard Co. supply rheostats with from 35 to 120 steps for small motors.

The Cincinnati Milling Machine Co. have standardized the electric drive arrangement for their milling machines, and are prepared to supply them with any one of half a dozen different makes of direct-current, variable-speed shunt-wound motors with a $2\frac{1}{2}$ to 1 variation in speed. This does not completely end the trouble, however, because all of the motors differ in shape and size, so that special parts are necessary in adapting them to the machine. In order to manufacture motor drive parts for machine tools economically by making them up in lots for stock, motor frames must be standardized in the following respects: 1, size and shape of base; 2, distance from center of driving pulley to center of base; 3, height of motor from bottom of base to center of armature shaft; 4, diameter of armature shaft. The minimum speed of motor should be somewhere below 700 revolutions per minute, and a speed variation of $2\frac{1}{2}$, or at most 3 to 1, would meet the problem satisfactorily. While the advantages of such standardization are at once obvious for machine tool builders, it is believed that they would be as great from the standpoint of the electrical manufacturer, as they would enable him to enter into competition on an even basis with his competitors, and he would be able to make up these motors and carry them in large quantities. The combination of the reduced cost of motor and of tool would materially reduce the now almost prohibitive selling price of motor-driven tools.

At present prospective purchasers of electrically-driven machinery become much discouraged, and often drop the matter, when they find they must wait a long time for delivery. All this would be eliminated by standardization.

W. H. Powell, of the Bullock Electric Mfg. Co., outlined the leading methods of speed control now in vogue. He then stated that in all of these systems, and also where motors are operated at a standard speed, the size and weight of the motor are dependent to a great extent on the minimum speed at which the motor is required to develop its full rated power. The slower the minimum speed the greater will be the size and weight for a given horse power.

As a gear or chain drive is used on motors operating tools the maximum speed of the motor is dependent on the tooth speed of the motor pinion or chain constructed; or upon the maximum ratio of speed reduction between the driven shaft and the motor shaft. The maximum speed of the motor on most machine tools varies from 1,000 to 1,800 revolutions per minute. Assuming 1,500 revolutions as an average value for the maximum speed, Mr. Powell then went on to show how the output of a given size of motor frame and armature core varies with the different methods of speed control. He explained that of the different systems the multiple voltage system would give the greatest horsepower output for a certain size of frame and weight of machine, provided the speed range were the same with all the systems. The multiple-voltage system, however, requires a separate balancing set, and an increase in the number of transmission wires to the motors. There is therefore a demand for variable-speed motors operated on the two-wire system. For this system motors with special commutating poles or compensating coils have been placed on the market with a speed range as high as 6 to 1. A properly designed motor without these special parts can be operated through a speed range of 3 to 1 without undue heating at the lower speeds, and without sparking at the higher speed; but no matter what the design of motor or the method of speed control, the size and weight, and consequently the cost, are dependent on the slowest speed at which the motor is required to develop its full rated power. It is, therefore, desirable to keep the speed range down to a reasonable amount which in his judgment is 3 to 1, with a minimum speed of 400 to 660, depending on output of motor.

Other representatives of the association and of different electrical companies also made remarks, and finally a committee was appointed to confer with manufacturers of electric motors and submit recommendations as to standard mountings and dimensions at the next meeting, which is to be held at Washington, D. C.

A feature of the Machine Tool Builders' convention was the special train run by MACHINERY for members and their guests through the entire length of the Subway, luncheon being served on the train at 157th Street. There was a large attendance of machinery manufacturers and dealers on this train, more than twice as many being present as at any previous function for the Association.

A sheet containing an explanation of some of the important facts in regard to the Subway was distributed to the guests, and as these will be of interest to many readers, they are published herewith.

SUBWAY NOTES WORTH PRESERVING.

The general form of the subway is that of the letter Y, with the base at the southern extremity of Manhattan Island, and the fork at 103d Street and Broadway, one branch running up the western side of the city, and the other branch passing beneath the upper end of Central Park, thence in an easterly direction to the Borough of the Bronx.

The main downtown station is at Brooklyn Bridge, from which a single-track loop passes around under City Hall Park, where City Hall station is located.

At Astor Place is a station connecting with the new Wanamaker store, now building. This is destined to be one of the most important trade centers of the city.

At 14th Street is the first express station. At 23d Street the subway station is somewhat novel in that there is provision for underground stores with show windows. At 34th Street the subway goes lengthwise under the Park Avenue tunnel, through which the Madison Avenue surface cars run.

At 42nd Street is the next express station, connecting with the Grand Central Depot. The time required to reach the Grand Central from Brooklyn Bridge by an express train is about 8 minutes. Express trains run through to 96th Street.

At 42nd Street an abrupt turn is made, and the subway passes along 42nd Street to Broadway, thence uptown under Broadway.

At 96th Street (also at City Hall loop) where it has been necessary for the passenger tracks to cross, grade crossings have been avoided by having one track or set of tracks pass under the other at the intersecting points.

From about 125th Street to 133d Street the road emerges and passes over the Manhattan Viaduct. It then tunnels under a height of land to a depth of some 150 feet at the deepest point. Trains now run on this branch to 157th Street, and when the track extensions are completed they will go to Kingsbridge Station, a total distance of 13½ miles from Brooklyn Bridge.

Branch Lines.

The branch running from 103d Street to the Bronx has not been opened to the public, but is so far completed that trains will be run to 145th Street, Manhattan, on this line in about two weeks, and later they will run under the Harlem River to the Bronx. This part of the subway will be of particular interest. The tubes under the river are built up of cast iron segments covered with concrete, the interior diameter being 15 feet. The approaches to the river are of arched concrete construction.

The subway is also being extended south from City Hall Park under Broadway. This is known as the Brooklyn Extension, and will run to South Ferry, thence under the East River to Brooklyn, thence nearly to Prospect Park, connecting with the Long Island Railroad.

Construction.

From Brooklyn Bridge to 96th Street the line has four tracks, then three tracks to 145th Street. On the Bronx branch there are two tracks in the section now building. The Brooklyn extension will also be a two-track line. From Brooklyn Bridge to 96th Street, where the express service is given, the two inside tracks are for express trains, and the two local tracks for local trains. An interesting feature of certain of the local stations is that the grade of the local tracks is raised at the station above the level of the express tracks in order to obtain quick acceleration for the local trains in starting and at the same time maintain a level grade for the express service.

Concrete construction was extensively used in the subway. The typical structure, where the subway is near the surface, consists in a flat roof of concrete supported by I-beams and columns at frequent intervals between the tracks. The side walls are of concrete in which are laid vitrified conduits for the electric cables. This construction is modified according to requirements. In some cases concrete arches are used and in others reinforced concrete construction. To make the structure impervious to moisture, there has been laid beyond the side walls, under the floor, and over the roof a course of felt washed with hot asphalt. Where tunnelling at a considerable depth was necessary, concrete lining was generally employed.

The track construction is of the usual standard with broken stone ballast, timber cross ties, and 100-pound rails. It is to be noted that the third rail is protected by an overhead guard.

The subway stations were the pride of the city before they were disfigured by the advertising signs placed in them by the operating company. The color effects of the tiling, the varied designs of the different stations, the attractive ceilings, the light and spacious appearance of many of the stations, make them unusually attractive, and the intention was to so modify the decorative design as to enable one to recognize a station by its appearance as well as by the conspicuous signs erected at each station.

Power House.

The power house for operating the subway trains—the largest steam plant in the world—is on the west side of the city, between 58th and 59th Streets. The plant provides for a single row of large vertical engines and electric generators, aggregating 100,000 horse power at normal rating. A sectional scheme was adopted for the plant, each section comprising one chimney, twelve boilers, two engines with generators, condensing equipment, etc. Four of these sections are contemplated, and in addition a steam turbine outfit is in operation, consisting of three turbines of about 2,000 kilowatt capacity.

Cars.

The subway cars are a modification of the type that has been used on the elevated roads of New York City. These have the motorman's compartment located on the platform. The side of the compartment is formed by a door which can be placed in three positions: (1) to separate the cab from the rest of the platform, (2) to close the opening at the rear of the car, in which position it is placed on the rear platform of the train, and (3) swung back to enclose the controller, in which position it is left on all the platforms except the front and rear, so that the entire space is available for the ingress and egress of passengers.

The platforms have doors instead of gates arranged to slide into pockets in the side framing. The side walls of the cars incline inward slightly toward the top. The lower sashes of the windows are fixed to prevent passengers from injury by leaning out and coming in contact with the subway posts; the upper sashes, however, can be lowered.

A part of the rolling stock consists of steel cars designed to be fire- and "collision"-proof. The interior finish of these cars is largely of aluminum, and while it lacks the beauty of the mahogany finish of the wooden cars, this objection may be offset by the sense of safety felt by the passengers.

The motor equipment of the cars is unusual. A train of eight cars is equipped with motors aggregating 2,000 horse power, and in consequence a high degree of acceleration is obtained. The rate of energy absorption in starting these trains is not far from double that taken by the heaviest trains on steam roads when starting from stations. By the use of the multiple-unit system of electrical control, the motors on the several cars are operated from the controller at the front of the first car. In an eight-car train, the first, third, fifth, sixth and eighth cars will be motor cars, which arrangement enables the train to be shortened by uncoupling cars from the rear.

Lighting.

The subway is lighted independently of the current operating the trains. It is for this purpose that the steam turbines in the power station are employed. This arrangement was made in consequence of the accident in the subway of Paris in 1903, when, owing to a collision, the tunnel was in total darkness. The lamps in the subway itself are so shielded that their glare will not blind the motormen.

Signals.

The trains are protected by an electro-pneumatic block and interlocking system, which has been worked out to a degree of perfection probably not before attained. The plans for the operation of trains contemplate local trains at one-minute intervals, and express trains at two-minute intervals. This means that so many thousand people will be traveling in the subway with trains near together that it would not be safe to entrust their lives entirely to the motormen. The signals are there-

fore connected with pneumatic stop levers which rise beside the right-hand rail of each track when a signal is set against a train, and if the motorman should allow his train to pass the signal the current would be shut off automatically and the brakes applied. The length of blocks was determined by many careful experiments upon the length of track required for a train to stop with the brakes applied. Instead of the "home" and "distance" signals as usually employed on steam roads, the so-called overlap system of signaling is used, by which a train that has stopped is always protected by two home signals in the rear, indicating an absolute stop, and three caution signals in addition to the automatic stop at the second home signal at the rear of a train.

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NOTES UPON BALANCING HIGH-SPEED MACHINERY.

In the article upon the shop methods of the De Laval Steam Turbine Company in the November number was an illustration of a machine for the accurate balancing of the rotary parts of turbines. Reference was made in the article to the so-called "critical speed" of bodies rotating with high velocity and the purpose of what is here written is to explain this and certain other points connected with the subject of balancing.

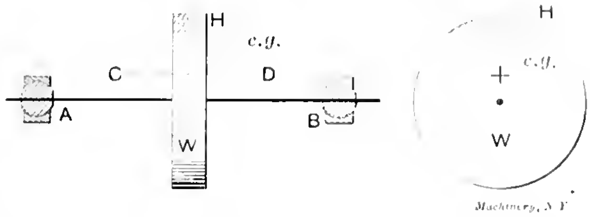


Fig. 1.

In Fig. 1 is a disk W mounted on a shaft A B turning in ball-and-socket bearings, as indicated. One side of this disk is supposed to have a dense section at H, making it heavier than the opposite side. The center of gravity of the wheel, therefore, will lie to one side of the shaft A B, say on the axis C D. Now if this shaft and disk be rotated, the centrifugal force generated by the heavier side will be greater than that generated by the lighter side diametrically opposite to it, and the shaft will deflect toward the heavy side, as in Fig. 2, causing the center of the disk to describe a small circle, indicated by the dotted line at a. To locate the point at which a weight should be added, or on the other hand, at which metal should be drilled out in order to bring the piece into balance, a piece of chalk is held so that the high side of the disk will just touch it as it comes around. The weight necessary to balance, to be told by trial, is then added opposite to the high side where the mark appears; or else, if the balancing is to be done by drilling, metal is removed on the same side with the mark. In the most accurate balancing it is advisable to use a steel point held rigidly, but which can be fed up gradually until the point makes a faint scratch on the edge of the disk.

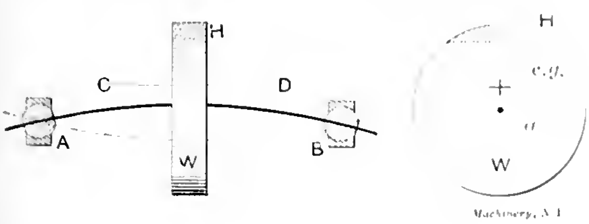


Fig. 2.

The foregoing conditions hold until a comparatively high speed is reached, depending upon the weight of the disk and flexibility of the shaft. A point will eventually be reached, however, at several thousand revolutions a minute, when there will momentarily be excessive vibration, and then the parts will run quietly again. The speed at which this occurs is called the critical speed of the wheel, and the phenomenon itself is called the settling of the wheel. The explanation is that at this speed the axis of rotation changes and the wheel and shaft, instead of rotating about their geometrical center, begin to rotate about an axis through their center of gravity, or about the axis C D in Fig. 1. This is illustrated in Fig. 3, where the wheel and shaft have taken a new position in which the axis C D, if extended, would pass through the centers of the two bearings, while the shaft is deflected so that it traces a circle shown by the dotted line b in Fig. 3. It is to be noted, however, that this circle is now on the H, or heavy, side of the disk instead of on the other side as before, so that now if one were trying to locate the point where weight should be added in order to balance the disk, he would find that the chalk mark came on the light side of the disk, and that the weight should be added on the same side.

Mr. Konrad Anderson says,* It is supposed that the settling of a rotating body occurs when the number of revolutions is equal to the number of vibrations which the shaft makes with the wheel mounted upon it. That is, a shaft and wheel have a

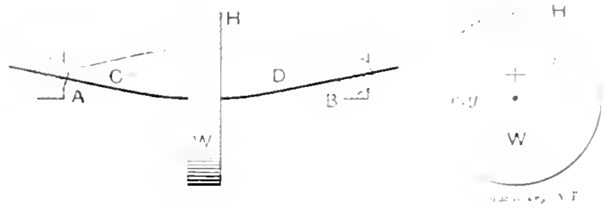


Fig. 3

certain time of vibration, just as does a pendulum or spring and when this synchronizes with the time of rotation the change is supposed to occur. In the De Laval turbine the flexible shaft and wheel are in such proportions that the settling takes place very quickly, and the critical speed is from 1-5 to 1-8 of the normal number of the revolutions of the wheel. Mr. Anderson gives the following empirical formula for determining the critical speed, in which C is a constant to be found by experiment for wheels and shafts, or other rotating parts of a certain design. Having determined the constant for one size he finds the formula to apply very nearly to every size of similar proportions.

n = critical speed.
P = force in pounds to bend shaft a certain distance.
Q = weight of turbine wheel.
C = constant.

$$n = C\sqrt{\frac{P}{Q}}$$

In referring to the subject of balancing, Francis Hodgkinson states† that "in the cases of heavier and bigger bodies, which would have a lower rotative speed, the marks do not come exactly on the light side. They may sometimes come as much as 90 degrees ahead of the light side. The exact angle can

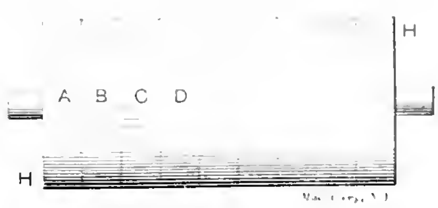


Fig. 4

only be found by experiment, and at best this is only a cut-and-try method. With experience, however, work may be put in very accurate balance."

In the illustrations thus far shown, the body to be balanced is represented as a disk supported by a flexible shaft. While it is only in special cases that the flexible shaft would be used, it serves to illustrate the principle of balancing better than if the shaft were rigid. If a disk were mounted on a rigid shaft and the rotative method of balance were to be applied, it would be necessary to support the shaft in bearings loosely connected to their pedestals, which would allow the shaft and disk to vibrate freely under the action of the forces generated.

In attempting to balance a cylinder, like Fig. 4, the heavy section is likely to come at or near one end, as shown at H, and there might, in fact, be another heavy spot diametrically opposite at the other end, as at H', so it is obviously better to divide the cylinder into a number of disks, A, B, C, D, etc., and balance each one separately. This is not always possible, however, as in the case of the running parts of electric

* Trans. Inst. Eng., Shipbuilders in Scotland, N...
† Proc. Eng. Soc., West Pa., Nov...

generators, for example, in which the winding is liable to throw it out of balance. The only way with such parts, which are usually of a cylindrical shape, is to mount them in loose bearings, as mentioned above, and run them up to speed by belt or other available means. There was published in MACHINERY for August, 1899, a description of an apparatus for this method

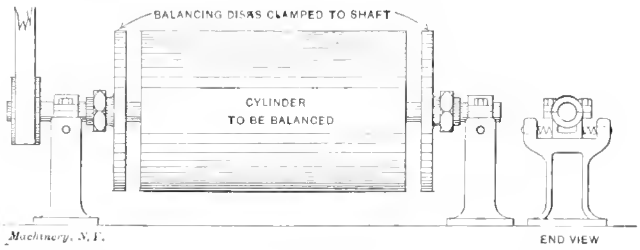


Fig. 5.

of balancing that has been used in balancing the cylinders of wool carding machines which run at a speed of about 1,000 revolutions a minute. The plan is illustrated in Fig. 5. The cylinder to be balanced is carried by a shaft supported by bearings loosely attached to their pedestals, and are preferably held to a slight extent by springs, although these were not used in the original design. On each end of the shaft is a carefully-balanced disk having a taper, split sleeve on which screws a taper nut, for the purpose of clamping the disk to the shaft in any desired angular position. Two diametrically opposite holes are drilled near the edge of each disk for the purpose of attaching balancing weights. When the cylinder is run at speed the end that is out of balance will throw out and is marked with a piece of chalk. The cylinder is then stopped and the disk at that end moved around until one of the holes comes opposite the mark, when a weight of what is thought to be the right size is attached and another trial is made. After repeated trials for each end of the cylinder the correct running balance is attained and then balance weights are made, weighing the same as those attached to the disks, and fastened to the cylinder in the same relative positions occupied by the weights on the disk. By this method there is no difficulty in applying the appropriate weight to the correct end of the cylinder.

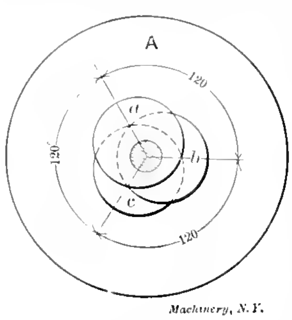


Fig. 6.

Some years ago William Sellers & Co., Inc., Philadelphia, conducted a series of tests upon an experimental steam turbine, similar in principle to the present Curtis turbine. As the disks rotated at very high speed, some convenient method of balancing was sought and the plan illustrated in Fig. 6 was originated. This will be the last to which reference will be made in the present article. In the figure *A* is the disk to be balanced and *a*, *b* and *c* are three thin disks turned up in the form of eccentrics and mounted on the shaft with the main disk. The bore of the eccentric was a close fit on the shaft, so there will be some frictional resistance between the eccentrics and the shaft; yet they were not so tight that it was necessary to drive them in place. The eccentrics were spaced 120 degrees apart and as the main disk attained its speed the eccentrics gradually shifted, automatically, until they reached such positions that apparently brought themselves, together with the disk and shaft, into perfect running balance. Just why the vibrations of the shaft were such as to cause this behavior of the eccentrics is a problem for the mathematicians to handle, but such is the fact, and we will leave it for others to explain.

* * *

F. B. Bristol, of the Bristol Co., Waterbury, Conn., was killed in an automobile accident on the evening of November 21. Mr. Bristol had been delayed at the works and wishing to gain time started for his home in his automobile at a high speed. He collided with a train while crossing the tracks at Platt's Crossing and was killed. Mr. Bristol was 45 years of age.

A LOST (?) INVENTION.

"Fame and fortune await the lucky individual who can rediscover the combination of metals from which the Egyptians, the Aztecs and the Incas of Peru made their tools and arms. Though each of these nations reached a high state of civilization, none of them ever discovered iron, in spite of the fact that the soil of all three countries was largely impregnated with it. Their substitute for it was a combination of metals which had the temper of steel. Despite the greatest efforts, the secret of this composition has baffled scientists and has become a lost art. The great explorer Humboldt tried to discover it from an analysis of a chisel found in an ancient Inca silver mine, but all that he could find out was that it appeared to be a combination of a small portion of tin with copper. This combination will not give the hardness of steel, so it is evident that tin and copper could not have been its only component parts. Whatever might have been the nature of the metallic combination, these ancient races were able so to prepare pure copper that it equaled in temper the finest steel produced at the present day by the most scientifically approved process. With their bronze and copper instruments they were able to quarry and shape the hardest known stones, such as granite and porphyry, and even cut emeralds and like substances. A rediscovery of this lost art would revolutionize many trades in which steel at present holds the monopoly. If copper could thus be tempered now its advantage over steel would be very great and it would no doubt be preferred to the latter in numerous industries. It is a curious fact that though this lost secret still baffles modern scientists it must have been discovered independently by the three races which made use of it so long ago."

The above item from a Sunday paper is an example of many such floating about which both reflect and impress an exaggerated sense of the importance of a so-called lost invention or art. The writer says: "A rediscovery of this lost art would revolutionize many trades in which steel at present holds the monopoly." Why would there be any revolution? Is any man sighing for a copper razor, or does any boy want a brass jack-knife blade? There is no evidence to prove that the tempered copper tools of the ancients were capable of holding a keen edge like steel; on the contrary they were probably very crude and unsatisfactory substitutes for what we now have. As a matter of fact there is no difficulty in making hard alloys. The United States Government Board, appointed twenty-five years ago to test iron, steel and other metals, reported through their chairman, Prof. R. H. Thurston, in that portion relating to copper-tin alloys that alloys of copper 72.89, tin 26.85, tin 29.88, copper 68.58, tin 31.26; copper 67.87, tin 32.10; and copper 65.34, tin 34.47 were all so hard that they could not be turned in a lathe with steel tools. These and other hard combinations have been generally known to the trade for years, but of what good are they? Copper and its alloys are more costly than the ordinary grades of tool steel, and the only apparent advantage possessed is that they are incorrodible. It is difficult to understand that this would be the cause for any revolutionary change, and we are forced to the conclusion that such statements are what, in current slang, is known as "hot air."

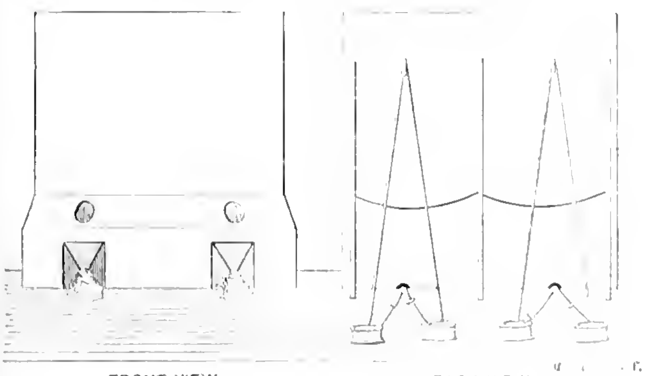
* * *

In common with other affairs of life some of the most simple and apparently obvious facts of steam engineering have only been learned after long experience and endeavor in a contrary direction to natural laws. Years ago before the days of the distillers on board ship for supplying fresh water to the boilers it was the practice in the United States Navy to use salt water for the "make-up," *i. e.*, to supply the water lost by leakage and other wastes. The rule was never to allow the salinity of the boiler water to exceed 1½ per cent of saturation. But, of course, it happened more than once that this rule had to be broken on account of leaky boilers, stress of weather or other reasons which make it impossible or unsafe to blow off and replace with sea water. Under such circumstances the surprising result was always noted that the scale deposits were more friable and easily broken loose from the sheets and tubes so that cleaning the boilers was an easier task than when the salinity had been kept down to the prescribed percentage. The reason, of course, was that when the salinity was kept at a low percentage more sea water had to be pumped into the boilers which introduced more lime and other scale-making properties. The lime being thrown down at once, formed a hard insoluble scale that could be removed only with difficulty. With less seawater introduced less lime was deposited, hence known as "hot air."

IRON AND ITS EARLY MANUFACTURE IN ENGLAND.

A. R. BELL.

That iron was first worked by the Phœnicians is only a probable conjecture, but they were, we are told, skilled in metallic ores, and proofs remain of their having worked the tin mines in Cornwall. There is every evidence, however, that iron was worked in England during the time it was occupied by the Romans, and during the Danish settlement in England the art of manufacturing iron was much improved. It appears malleable iron was made during that period in a footblast furnace, Fig. 1, the simplicity of which is interesting, showing what may be effected by very limited means. The excellent quality of the iron turned out from these rude furnaces compares favorably with that now supplied by the great iron works possessing huge capital and extensive laboratories, for when the art was but little advanced the most tractable ores were selected and charcoal was invariably used as fuel, circumstances which in themselves are sufficient to account for the iron being of high quality. Each furnace measured about 8 by 16 inches at its mouth, and was about 3 feet deep, terminating in the form of a funnel over a shallow pit inclining outward. The furnaces were constructed in a bed of clay about 3 feet high and 3 feet wide, against which a light wall about 10 feet in height was raised to protect the bellows and the furnaceman located immediately behind. Each bellows consisted of a circular rim of wood about 6 inches in diameter and nearly 2 inches high,



FRONT VIEW BACK VIEW

Fig. 1. An Early Form of Foot Blast Furnace.

fixed on a clay floor and covered with cowhide, with a hole in the center to admit air and to receive a cross stick fastened by a cord to an elastic stick above. Each pair of bellows was worked by a boy, who rested his back against a rope for the purpose of support and stepped alternately from the orifice of one bellows on to that of the other, at each step forcing a blast of air into the furnace through a tube of bamboo. The furnaces were charged with a mixture of charcoal and iron ore broken into small pieces. The fires were kept as strong as possible until the ore was reduced and the fused metal collected in a cake on the ash-pit.

At the time when separating the metal by footblasts was in vogue, the art of casting iron was unknown, or at least not practiced, but in the sixteenth century blast furnaces were of a sufficient size to produce, with ores and the charcoal of wood, from two to three tons of pig iron per day. This output, however, was only attained in suitable situations and where water power was available, while the greater part of the ore was made into bar iron in a refinery; at the smaller works it was made malleable before being withdrawn from the furnace. When wood became scarce, pit coal was substituted for making pig iron. Mr. Simon Sturtevant in 1512 had a patent granted him for this purpose, but the process proved to be unsuccessful. It is strange that although pit coal was known long before this period and large quantities were shipped to Holland and Belgium, where it was used in the smith's forge and in other manufactures, yet in England the prejudice against its use in the manufacture of cast iron was so keen that when it was first proposed every obstacle that could be devised was brought in its way, consequently none of the adventurers who attempted to use it were successful. In 1619 Captain Buck, Major Wildman, and others constructed air furnaces in the Forest of Dean, in which they placed large clay pots for containing the requisite preparations of ore and charcoal, the flame of pit coal being employed for heating the furnaces. It was expected that by tapping the pots below, the separated metal would flow out, but it was found that the heat was not sufficiently intense to produce an entire separation of the metal, the pots cracked, and the work was abandoned. At this time the price of iron was advancing in consequence of many of the iron works having stopped for want of fuel, and those who were able to obtain supplies of

Fig. 2. Early Form of Coke Oven, Beehive Pattern

wood were making high profits from the manufacture. Dudley in his "Metallum Martis" states that his father and himself had smelted iron with coke in large quantity, but that Oliver Cromwell and several of his favorites, who wished to become partners and were refused, ruined the establishment. The brittle quality of English bar iron, made from coke at this period, and the great expense of that which was made from charcoal, owing to the increasing scarcity of wood, were most likely the causes of the great decline in the home manufacture which then took place, and importations from Russia and Sweden were made on a large scale. Later the steam engine afforded the British manufacture a means of renewing the industry; the small furnaces supplied with air from bellows

Fig. 3

worked by oxen, horses or men were given up, and larger furnaces were introduced with blowing machines to make an increase of the column of air and effect a more complete combustion. Experience also proved that the produce of the furnace could be increased by enlarging the diameter of the steam cylinder and rendering the vacuum therein more perfect.

The making of coke was performed on a rectangular-shaped hearth prepared by beating the earth to a firm flat surface and padding it over with clay. On this the pieces of coal were piled inclining one to another, those of the lowest layer being set so as to touch the hearth with the smallest surface. The piles were usually from 30 to 50 inches high and from 9 to 16 feet square, and contained from 40 to 100 tons of coal. Vents were left reaching from top to bottom into which burning fuel was thrown, and were afterward closed by pieces of coal driven firmly in; thus the kindled fire was forced to creep along the bottom and eventually burst out at the sides. If the coal contained pyrites the combustion was allowed to continue after the smoke had disappeared to extract the sulphur. The fire generally lived from 60 to 70 hours, but the coke was not removed for at least 12 and sometimes 14 days. The annoyance attending this process by the evolution of the immense quantities of smoke and the tremendous waste of volatile products induced Lord Dundonald in 1781 to improve the system, and he introduced what were known as tar works. The ironmasters sent the raw coal to the tar works and received in return coke, the "tar works" being compensated for their trouble by retaining the valuable commercial products, tar-pitch, varnish and ammonia. Coke kilns, or ovens, were first introduced near Sheffield about 1840. They were hemispherical or beehive in shape (see Fig. 2), about 10 feet in diameter at the base and about 2 feet at the crown with a circular opening at the top for introducing the coal, and once heated, were allowed to burn day and night without interruption. The method of charging a coke oven was as follows: Sufficient small coal was thrown in at the top

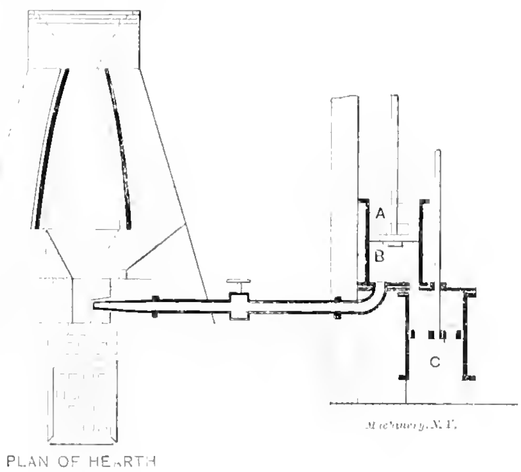


Fig. 4

to fill the oven up to the springing of the arch. It was then leveled with a rake, and the doorway at the side filled with loose bricks. The heat acquired by the oven from its previous charge was sufficient to light up the new one, the combustion being accelerated by the air finding its way through the joints of the blocks in the doorway. In a few hours the combustion reached such a height that it was necessary to reduce the influx of air, and the doorway was therefore plastered up with wet mud and sand, leaving only the top row of bricks loose for the inlet of air. After twenty-four hours of burning this inlet was also closed, and only the chimney remained open until the flame was dead, when a few loose stones were laid over the aperture at the top, and covered up with a thick bed of mud. All was then air-tight and was allowed to remain in that condition for about twelve hours to complete the operation, after which the doorway was opened and the coke raked into iron barrows for its removal.

The process of roasting iron previous to smelting in a furnace, seems to have been introduced mainly by Mr. Teague, of Calford, Gloucestershire. He took out a patent in 1832 for smelting iron, in which he proposed to economize by roasting the ore, and instead of the calcination being a distinct process, he combined the operations of roasting and smelting. For this purpose he constructed around the chimney shaft near the top a series of four small reverberatory furnaces, each provided with a damper at the top, and a lateral door which opened outward. Through these doors the ores to be roasted were introduced on to iron plates, which formed the bottom surface. The ascending flames from the smelting furnace were prevented from passing out vertically, as usual, by means of a trap door, *A*, as shown in sketch, Fig. 3, this causing the hot gases to pass through the oven and impinge on the ore, thus depriving it of its volatile combinations. When the ores were sufficiently operated upon they were thrust forward into the smelting furnace, and while the roasting furnaces were being recharged, the trap door,

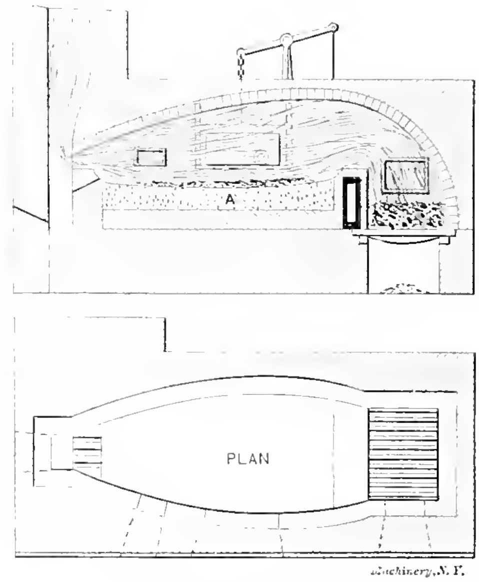


Fig. 6.

A, was open to the shaft so that the flames might ascend directly by it. An early form of smelting furnace introduced by Mr. David Mushet is shown in Fig. 4, the external form being that of a truncated pyramid. This type of furnace differs in no essential details from the present-day one, excepting in the blowing machinery. The regulating cylinder shown at *A* was about 8 feet in diameter, and the floating piston, *B*, was loaded with weights varying according to the power of the blowing engine. The blowing cylinder, *C*, was about 6 feet in diameter and 7 feet stroke. The following leading dimensions of the furnace will be of interest: The hearth was about 2 feet square at the top of the boshes, the furnace was about 12 feet in diameter and about 8 feet high. The top of the furnace was about 3 feet in diameter, and the internal cavity of the furnace from the top of the boshes was about 30 feet high. The plan of the foundation, built of stones and bedding sand, is shown. To start the furnace loose fuel was thrown in at the bottom and a few baskets of coke introduced to become thoroughly ignited; the cavity was then gradually filled. The first charge received but a small portion of iron-stone compared with the weight of coke,

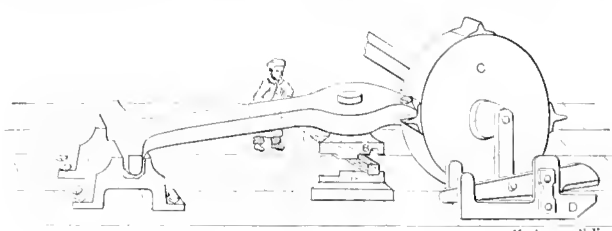


Fig. 7.

but after a few days the iron-stone was gradually increased in proportion, and when once started these furnaces were allowed to burn for several years. For smelting by means of anthracite coal, Mr. Mallin invented the furnace shown in Fig. 5. For his experiments he used a hearth of only 11 inches in diameter at the tuyeres, the blast being introduced as represented in the plan. He found that the blast required to work the furnace had to be under a pressure of at least 2½ pounds to the circular inch, and the quantity of air required for an ordinary furnace would not be less than 28,000 cubic feet per minute. At one time the prejudice against the use of anthracite was very strong, and it was used for a long

time in parlor and kitchen grates before it gained the attention of iron masters. The first attempt of puddling iron for depriving it of carbon and oxygen to render it malleable, was carried out in a furnace illustrated by Fig. 6. At *A* a basin of sea sand was spread in a concave shape supported by bricks on solid masonry, and on this bed of sand the metal was placed and exposed to the heat of the flames. The amount of air was regulated by dampers.

In Fig. 7 is shown an early form of shingling or blooming hammer, consisting of an anvil, *A*, with its block. On to this the shingler drew out of the furnace a stout flat bar, the end of which was brought to welding heat, and laid on the ball under the hammer, *B*, where they were welded and formed into one piece. The shingler was then enabled to turn the ball about upon the anvil, and meet every blow of the hammer, while the drum, on which were fixed four wipers or cogs, revolved, causing the hammer to be lifted, and then allowing it to fall by its own weight. The face of the hammer, it will be noticed, was not flat, but had channels and projections, and placing the bloom under these projections cross ways caused it to extend, or if placed in the other direction its breadth was increased. Attached to the crank at the side of the drum, was a pair of shears, as shown at *D*, used for cutting off the rough edges on the blooms. It sometimes happened through mismanagement on the part of the puddler that the bloom was not sufficiently freed from impurities for treatment under the hammer, and its indisposition was shown by a hissing or bubbling. It was then thrust back to the puddler, and he had to pay a fine for his carelessness in drawing it out of the furnace too early.

* * *

ELECTRIC REPAIRING.

THE COMMUTATOR.

NORMAN G. MEADE.

Norman G. Meade.

The most economical method of repairing electrical machinery in a manufacturing establishment, or electric railway plant, is a subject that should command the attention of the superintendent and electrician. The exorbitant charges of electrical repair concerns and the unnecessary delay in transportation of apparatus make it a practical necessity for companies of any magnitude to do their own repairing. In the present article a few suggestions are given for re-filling commutators. As the commutator is the part of a direct-current machine that is subjected to the greatest wear, its re-filling constitutes a large portion of the repairman's work.

It is always advisable, when possible, to purchase hard drawn copper strips, drawn to gage, and cut them to required lengths. Old commutators are frequently so far out of date that standard sizes of segments will not do. A very good commutator can be made from a copper casting, similar in shape to the assembled commutator, that is, cylindrical in form and enough larger than the original commutator to allow for finishing, Fig. 1. Large castings may be cored out at ends, *a* and *a'*, for collars, thus saving some stock and considerable labor, as it is then only necessary to make a finishing cut after segments are assembled. Bore out the rough casting and drive it on an arbor and place in "centers" of a milling machine. Use a 1-16 inch saw about four or five inches in diameter. Cut as many slots in the casting as there are to be segments, *b*, Fig. 2. By using an indexed head this is a very simple process. Cut the slots to within about 1-8 inch of through, as shown at *c*. The slots for armature leads should be cut in after the commutator is assembled and turned. Now, drive out arbor and catch casting in a vise and finish cutting through the slots with a hack-saw. Two blades put in the frame at the same time will make a cut about equal in width to that made by the saw in milling machine. File off any burrs that remain on segments and drill a hole in each one on flanged portion *a*, Fig. 3, in diameter about twice the width of slot cut for lead wires, and a little deeper. This hole aids greatly in soldering in armature leads, as the solder flows at once to the bottom of slot. The insulation between the segments should be micanite about 1-32 inch in thickness. As the segments are sawed up by a 1-16 inch saw, the rough casting must be made large enough to allow for the difference.

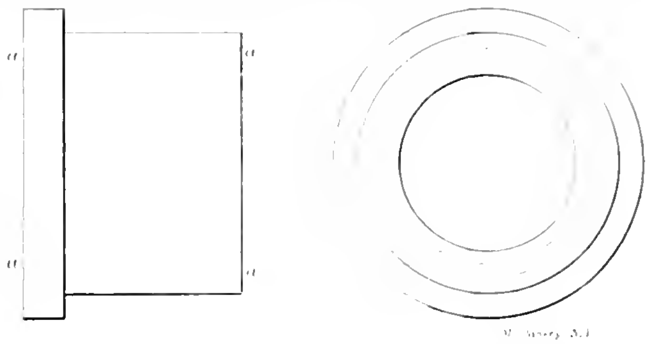


Fig. 1

For instance, in sawing up a casting into 32 segments, two inches of the circumference would be wasted. Using 1-32 inch micanite would make up for one inch only, so that the rough casting must be one inch greater in circumference—over and above the stock allowed for finishing—than the original size of the old commutator.

The next step is to assemble the segments in a suitable clamp, as shown in Fig. 4. This is a cast-iron split ring, the two parts, *c* and *c'*, being held together by bolts *d* and *d'*. A plan of section *c* is shown; *a* and *a'* are dowel pins, and *b* and *b'* are clearance holes for bolts *d* and *d'*. Great care must be taken in assembling the segments to have them all straight, that is, parallel with the axis of the commutator. Now, chuck the clamp, with the segments, in the lathe, and bore out the center to required diameter, then bore out the ends to correspond with the old commutator. A templet of tin made to fit the end bore of the old commutator is very convenient for gaging the new one.

It is more economical to make several commutators at one time, so that a temporary shaft, with collars and clamping nuts, should be provided. Such an arrangement is shown in Fig. 5, *d* being a short length of cold-rolled steel threaded at *c* and *c'*; *a* and *a'* collars bored out to slip over shaft, and *b* and *b'* clamping nuts. The temporary shaft should be firmly secured to the newly-bored segments before removing the clamping ring. This done, the ring may be removed and the new commutator will be ready for turning, as shown in section at *c* and *c'*, Fig. 5.

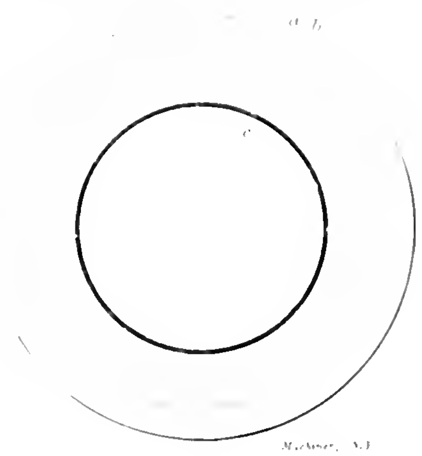


Fig. 2

Before turning, the commutator should be heated until the shellac oozes from the micanite, then placed on end on a surface-plate with a hole for shaft to extend through. This plate is shown at *d*, Fig. 6.

Place a try-square on the plate and sight along the blade

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to see that the edge of one of the segments coincides with it, as at *b* or *c*. If not, by using a small cold-chisel and hammer, drive the segment one way or the other until plumb. Go all around the commutator in this manner. After straightening all the segments, tighten up the clamping nuts again and allow the shellac to dry. After the finishing cut is taken, the com-

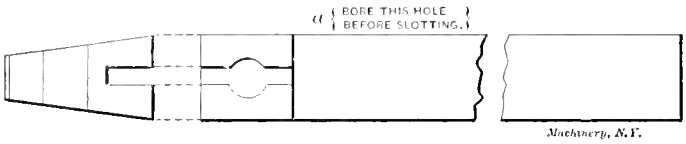


Fig. 3.

mutator should be returned to the milling machine and the slots cut for lead wires, as shown at *a*, Fig. 2. When all burrs have been removed, we are ready to put on the retaining band, which firmly holds the segments in place until used.

Fig. 7 shows a method of putting on the band. The segments, *a*, are placed between lathe centers, and a heavy piece of manila paper is wrapped around them, as shown at *e*.

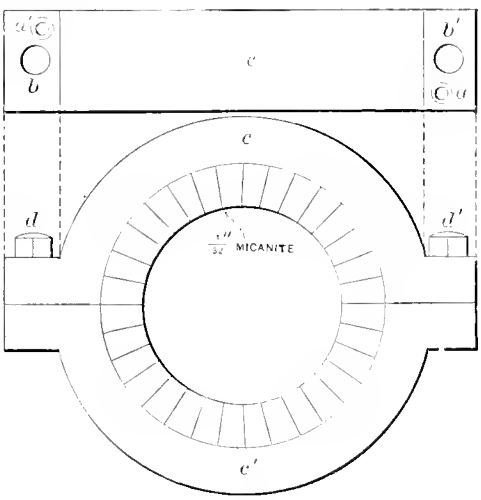


Fig. 4.

This is held in place temporarily by a cord, which also serves to hold in place a piece of 1-32 inch brass, *b*. Now cut two fiber friction blocks, *f* and *f'*, to fit in the toolpost, bore a hole and insert a pin in each, *g* and *g'*, to keep the blocks in place. Any amount of tension can be placed on the blocks by the clamping screw *n*.

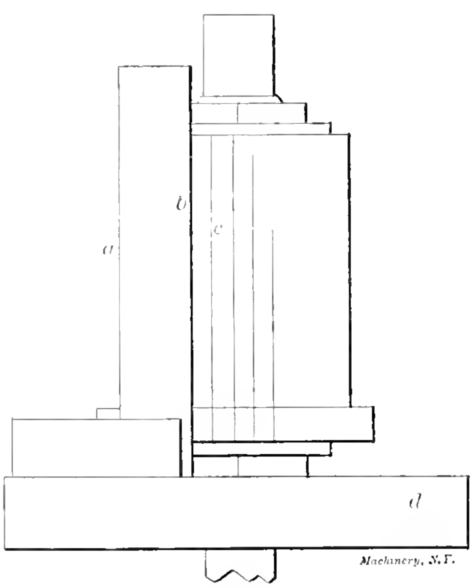


Fig. 6.

Take the end of a coil of No. 16 brass wire, and pass it between friction blocks, *f* and *f'*, and catch it in one of the slots, as at *c*. Turn the assembled segments two or three revolutions until the wire is brought over the paper *e*, then cover about one-half the length of the segments closely and very tight. When the desired amount of wire has been wound on, turn the ends *i* and *i'* of the brass strip *b* over on wire, and hammer down, bringing the turn *h* close up to the band. Flow solder over the band with an iron and cut off the ends of wire. The commutator may then be removed from temporary clamping device, when it will have the appearance shown in

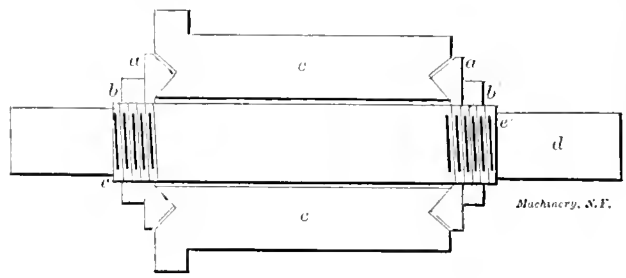


Fig. 5.

Fig. 8. A temporary clamping device, the clamping ring, and templets, can be used indefinitely. One clamping ring can be used for several sizes of commutators by using split bushings.

When removing old segments from a commutator, care should be taken to keep the molded mica insulation on the ends intact. If this is broken it can be replaced by canvas

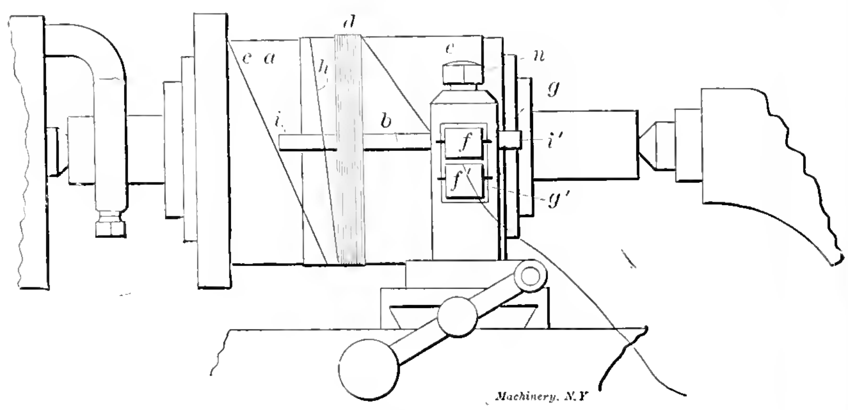


Fig. 7.

disks, shown in Fig. 9, made up of several pieces shellaced together to obtain a thickness equal to the molded mica. Place the old commutator sleeve, with the rear collar attached, end down on a bench and slip the canvas disk over sleeve to bottom. A hole in the disk should fit tightly over the sleeve, and the outside diameter be about one inch greater than that of

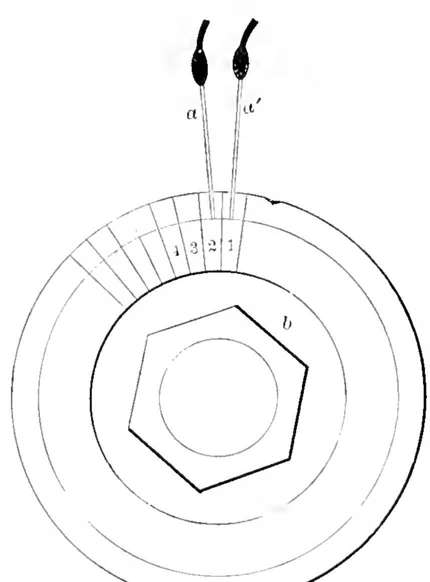


Fig. 14.

the commutator. A thin sheet of flexible micanite must be wrapped around the commutator sleeve, to insulate it from the inside of segments. After placing the assembled segments *b*, over the sleeve, slip on the upper canvas disk *a*, Fig. 10, then collar *b*, finally tightening up nut *c*. Canvas disks should be put in with shellac, wet. After screwing up the nut firmly,

allow all dampness to dry out thoroughly. The canvas disks will then protrude between collars and segments as shown at *a*, Fig. 11. Trim off smoothly, giving a finished appearance like *a* in Fig. 12.

The completed commutator is now ready for testing. A very convenient and fairly accurate method is shown diagrammatically in Fig. 13. A sixteen candle-power incandescent lamp is connected in series with the mains, and two flexible cords with solid copper tips, *b* and *b'*. Fig. 14 shows the application of the testing arrangement. The copper tips, *a* and *a'*, are placed on adjoining segments, as at 1 and 2. If there is a short-circuit, the lamp will light. Test each segment in turn in this manner. Then, by placing one of the tips on the end of the collar, as at *b*, and touching the other to each segment in turn, any leakage from segments to core will be found. If no leak is found the commutator is ready for use.

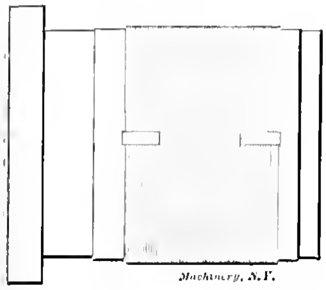


Fig. 8.

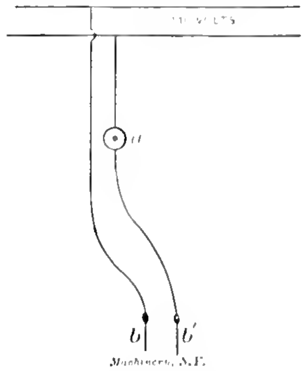


Fig 13

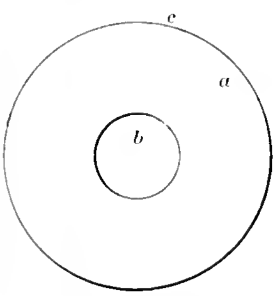


Fig. 9.

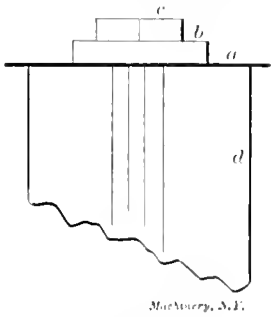


Fig. 10.

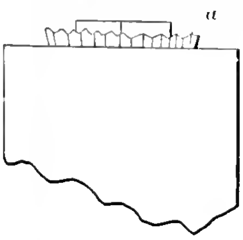


Fig. 11

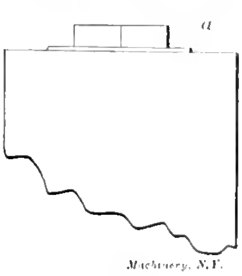


Fig. 12

If a leak or short-circuit appears, the trouble must be located and remedied before using.

Small copper chips wedged in the micanite by the turning-tool often cause a short-circuit between segments. A careful inspection inside and out after turning, will generally disclose any such defect.

* * *

THE SLIDE RULE—POSITION OF THE DECIMAL POINT.

S. E. WOODBURY.

The following method of locating the position of the decimal point in the result of multiplication or division when using the ordinary slide rule is submitted as being very much easier to learn and use than the several methods usually presented in the instruction books.

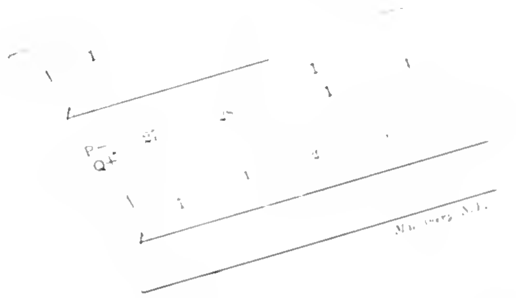
In the bottom of the groove under the slide at the left-hand end of the slide rule may be written the characters $\frac{P-}{Q+}$ (see cut). A clew to the method of using these marks is suggested by the fact that they are sometimes covered by the slide.

Assume the rule—The number of digits in a product is equal to the sum of the digits of the factors; and, the number of digits in a quotient is equal to the number of digits in the dividend less the number of digits in the divisor. This rule is true when the result is obtained with the slide projecting to the left, covering the characters $\frac{P-}{Q+}$

When the result is obtained with the slide projecting to the right, the number of digits in the result is corrected according to the indication of the characters, which are then visible. If the result is a *product* the number of digits is equal to the number obtained by the rule above given *less* one, as is indicated by *P*—. If the result is a *quotient* the number of digits is equal to the number obtained by the rule above given *plus* one, as is indicated by *Q*+. Since the correction is always one it is not included in the characters. This method is best used with the *C* and *D* scales; but can be used as well with the *A* and *B* scales after it is once understood.

If the same characters are written in the right-hand end of the groove, prefixed by *I* (signifying inverted slide), thus $I\frac{P-}{Q+}$ the decimal point in calculations effected with the inverted slide can be located equally as well.

Below are given examples in the four cases, more fully illustrating the use of the method. A little practice will



quickly reduce the operation to a simple mental calculation of scarcely any additional effort, besides reading the results from the scales.

Note.—In dealing with decimal quantities, the number of negative digits equals the number of zeros after the decimal point.

Multiplication.		Division.	
33.2 × .515 = 17.1		13.2 ÷ 30.4 = .434	
Digits in 33.2..........	+ 2	Digits in 13.2........	+ 2
Digits in .515..........	0	Digits in 30.4.........	+ 2
Adding gives......	+ 2	Subtracting gives.	0
P — invisible, no correction		*Q* + invisible, no correction.	
Digits in answer.......	+ 2	Digits in answer......	0
272 × .0318 = 8.65.		.0725 ÷ 36.8 = .00197.	
Digits in 272..........	+ 3	Digits in .0725........	— 1
Digits in .0318........	— 1	Digits in 36.8..........	+ 2
Adding gives......	+ 2	Subtracting gives..	— 3
P — visible correction.	— 1	*Q* + visible correction.	+ 1
Digits in answer......	+ 1	Digits in answer......	— 2

* * *

To harden and temper large fluted reamers with the appliances afforded by the average shop is trying enough by daylight, but when it must be done at night the combination of adverse conditions would ordinarily appal the average toolmaker. At night it is useless to attempt drawing the temper by the color, hence the resort to a fusible alloy to denote the proper heat for the desired temper. A toolmaker tells how he tempered a large reamer after dark for a rush job in a shipyard. After hardening the reamer, he heated it throughout until it would just melt an alloy made of equal parts of tin and lead. The temperature at which this melts corresponds closely to a straw color. Large tools should have the temper drawn at once after hardening, in order to relieve the internal strains; otherwise they are liable to crack.

TOOLMAKING.—12.

FORMING TOOLS AND MILLING MACHINE CUTTERS.

E. R. MARKHAM.

Forming tools are used when a number of pieces of exactly the same shape are to be made. They are extensively used on screw machine and similar work where it is desirable to duplicate a given shape, and are very valuable for giving the desired shape to tools of irregular contour when duplication of form is desirable. Forming tools are made either flat or circular, as seems best, or as the work to be done requires. When used for giving tools the required shape in the lathe or planer they are ordinarily made flat; if they are for backing off formed milling machine cutter teeth they are always made flat; when used on screw machines for giving a desired shape to the work they are made either flat or circular, although the latter form is more common.

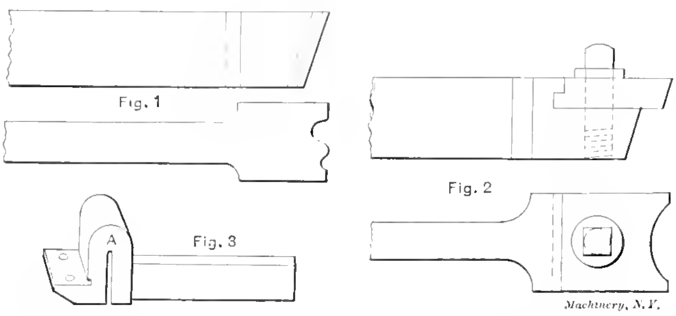


Fig. 1 Fig. 2 Fig. 3

Machinery, N.Y.

Flat forming tools are made solid; the tool and shank may be one piece, as shown in Fig. 1, or the cutter and shank may be made separate, as shown in Fig. 2. If but one forming tool is to be made, make the solid tool; but if many tools are to be made it is much cheaper to make a shank, as shown in Fig. 2, and separable cutters for the different jobs.

To reduce the tendency to chatter when heavy cuts are taken it is sometimes advisable to make a spring holder, as shown in Fig. 3. When tools of this character are subjected to heavy cuts they yield somewhat, thus producing a smooth cut. To give the spring portion, *A*, a spring temper it is necessary to make this holder of tool steel. The blades must of course be made of tool steel and may be planed up in long strips and cut to the desired lengths. The character of the work must in a measure determine the carbon of the steel used in the blades. For the general run of work, however, steel containing 1¼ per cent. carbon will be found satisfactory; if the facilities for hardening are such that the heats can be graduated very carefully it is safe to use steel of a higher temper than that mentioned.

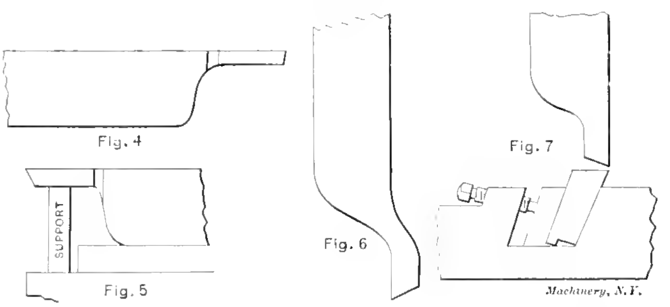


Fig. 4 Fig. 5 Fig. 6 Fig. 7

Machinery, N.Y.

When tools of the description shown in Fig. 1 are made it is often customary to make the portion which is to receive the shape or form like that shown in Fig. 4 in order to save labor when making the form on end. This works very nicely when light cuts are taken with the tool, or if the cutting surface of the tool is not too great; but for heavy cuts the tool will chatter unless supported as shown in Fig. 5.

When very smooth surfaces are desired it will be found necessary to run the stock slower than when cutting with tools of other form. Forming tools to be used in the shaper or planer, and where a smooth surface is desirable, may be made as shown in Fig. 6. These are known as spring tools, and irregular surfaces such as occur on the faces of bending dies and similar tools may be produced with these spring tools very quickly and very smoothly. This form of tool also works nicely when applied to other than forming tools, as cut-off tools, smoothing tools for flat surfaces, etc., for use in the shaper and planer.

In the making of solid flat forming tools extreme care should be exercised in the operation of forging. Tools of this class are subjected to great strain, and in order to insure satisfactory results should never be overheated, and should be hammered in a manner that makes them the strongest possible. After forging, the tool should be carefully annealed, as this operation insures best results when the tool is hardened.

The bottom (or base), the portion on which the tool rests, should be perfectly aligned by milling, planing, or if possible, by grinding; otherwise it would not be possible to produce the same form at different seatings. The top of the tool blank should be machined flat, and parallel to the surface it rests on, after which the form should be laid out, using a templet for this purpose.

The method used in working the desired form in the face of the tool depends on circumstances. If many tools of a given form are required, or if many pieces are to be made with a tool which would necessitate grinding it several times, a method must be used that insures uniformity of shape the entire vertical length of the face of the tool. If the tool is to be used but a little the desired form may be produced by filing; but as it would be almost impossible to file an irregular shape that would maintain its form the entire length of the face, each time the tool was ground, the shape of the pieces machined would change with each grinding.

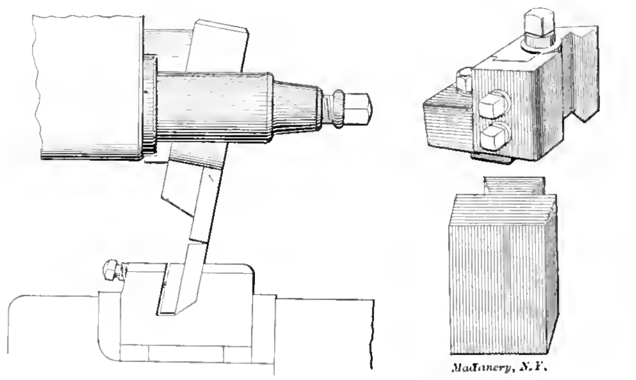

Machinery, N.Y.

Fig. 8 Fig. 9.

The tool may be held at the desired angle in the vise of the planer, shaper, or milling machine, if the form is to be produced by machining. The usual practice is to have a fixture which holds the work at the desired angle of clearance. According to the writer's experience forming tools to be used for the general run of work should be given a clearance of 10 to 15 degrees, that is the included angle to the top of the tool should be from 80 to 75 degrees. However, if the tool is to be used for backing off the teeth of formed milling machine cutters, it is necessary to give a clearance of 18 to 22 degrees.

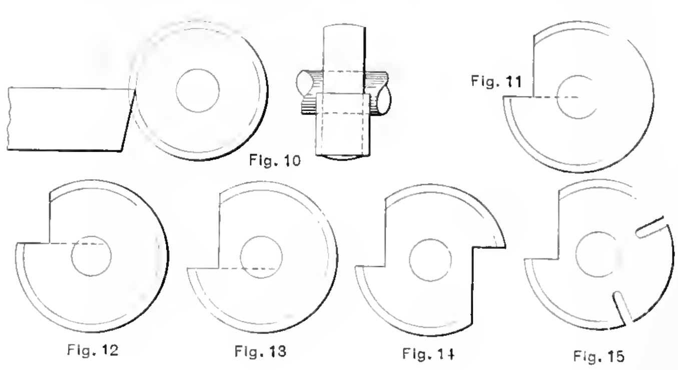


Fig. 10 Fig. 11 Fig. 12 Fig. 13 Fig. 14 Fig. 15

Machinery, N.Y.

It will be apparent that tipping the tool in the vise, as described, prevents duplicating the shape of the master tool, if that is held in a vertical position in the toolpost of the

shaper or planer, as shown in Fig. 7. To overcome this difficulty the master tool may be made enough different in shape to produce the desired shape; or the tool may be held in the toolpost, or in a special holder, at the same angle as the blank, as shown in Fig. 8, and it will produce a shape corresponding very closely with its own.

When forming tools are used continually, the form shown in Fig. 9 is considered in most shops the most satisfactory. The cutters are made separable, and held in the holder at the desired angle. As the cutters are held very rigidly extremely heavy cuts can be taken without the tool slipping or chattering. This tool recommends itself where the same form is to be duplicated right along, as the cutters are very easily and cheaply produced after the master cutters have been made. The shape may be worked in the face of the tool either by milling or planing; the former method is, generally speaking, the more satisfactory.

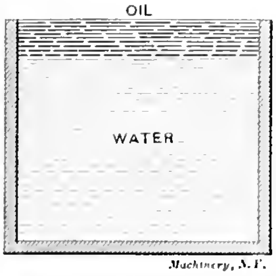


Fig. 16.

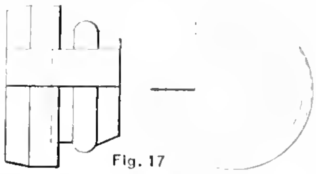


Fig. 17

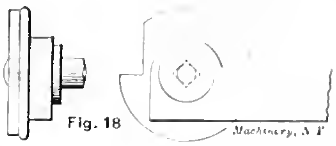


Fig. 18

Circular Forming Tools.

Circular forming tools are used very extensively on screw machine and similar work. They commend themselves on account of the ease with which any number of them may be produced, provided a master tool is used in producing the shape, as shown in Fig. 10. If the master tool is properly made, and does not project very far from the toolpost, it should produce a very smooth surface, provided the cutter blank is held on a short mandrel and is run extremely slow for the finishing cut. If the exact shape is not essential it may be given a very smooth finish by polishing with fine emery and oil on a soft pine block. This practice, while common, should never be resorted to when accuracy in contour is essential.

To provide a cutting edge the tool is milled as shown in Fig. 11. It is necessary to have the cutting surface radial as shown, if we desire to duplicate the exact shape of cutter. If the cutting edge is above the center, as shown in Fig. 12, the tool will not cut; if below the center, as shown in Fig. 13, it will cut very nicely but will not produce a correct shape. In many shops it is considered advisable to make the cut, as shown in Fig. 13, to insure rapid cutting, the form of the tool being somewhat different, to compensate for this. Before hardening, the name or the number of the tool is stamped on it. It is customary in some shops to mill two cutting edges, as shown in Fig. 14, in order to reduce the tendency to crack when the tool is hardened; at other times it is considered advisable to make two extra cuts, as shown in Fig. 15. However, if the tools are heated very carefully and dipped in a bath similar to that illustrated in the October number of MACHINERY (Fig. 19), the contraction is so uniform that there is little danger of cracking. It is necessary, of course, when using this bath to dip the tool so that the water issuing from the perforated pipes strikes the face of the tool. The pipe at the bottom that throws a vertical jet of water, should be closed to prevent the water being forced against one side of the tool, as this would cause unequal contraction.

If it is necessary to use an ordinary bath of water, or brine, the tool should be worked around well in the bath. When it is cooled the strains should be removed by reheating sufficiently to reduce the tendency to crack. If the form of the tool is such that it is not necessary to draw the temper it is ready for use after the cutting surface has been ground. If it is necessary to draw the temper, it may be done by heating in a kettle of oil, gaging the temperature by means of a thermometer; or the sides may be brightened and the temperature gaged by the color. Usually, however, sufficient toughness may be produced by drawing to a temperature that would not produce any temper color. In such cases it is necessary to use the heated oil and thermometer, as described. In some instances the brittleness may be reduced sufficiently by placing in a kettle of water which may be gradually heated until it boils, allowing the water, with the tool in it, to boil sufficiently long to insure the tool being uniformly heated to the temperature of the water (212 degrees F.). A method used in some shops with excellent results, consists in quenching the tool in a bath of water having a layer of oil about 1 inch on the top, as shown in Fig. 16. The heated steel passing through the oil into the water acquires a thin coating of oil, which lessens the shock incident to plunging red-hot steel into cold water.

The writer has had excellent results when hardening both flat and circular forming tools by the method previously described as "Pack hardening" (in the May issue of MACHINERY). The tools stood up nicely, and the tendency to crack was entirely eliminated; and in the case of circular forming tools which had threaded holes, the tendency to shrinking out of size was reduced to the minimum.

Circular forming tools having large and small portions adjoining, as shown in Fig. 17, are many times made of two or more pieces; this simplifies the operation of making and tools of this character can be hardened with less liability of breaking than if made in one piece. When possible the smaller portion should be recessed into the larger, as shown. This does away with the tendency of the smaller portion to crumble at the end which comes against the larger portion.

Forming tools of small diameter cut more rapidly than larger ones when the cutting edges of both are radial, as the metal below the cutting edge recedes more rapidly, thus giving a greater amount of clearance.

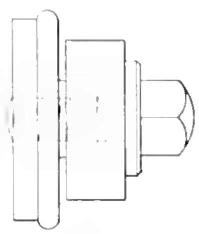


Fig. 19

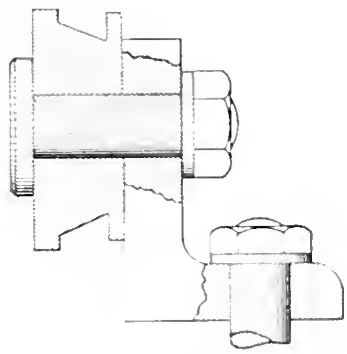


Fig. 20

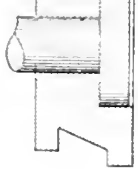


Fig. 21

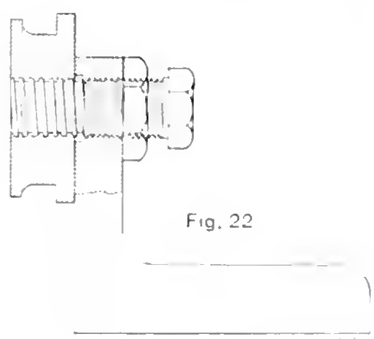


Fig. 22

Tool Holders. It is necessary to provide a holder for circular forming tools, the design depending altogether on the class of work to be done. For use in an ordinary hand screw machine the one shown in Fig. 18 answers nicely. If the work is light the flat side of the tool is drawn against the side of the holder by means of a screw. Fig. 19 shows a tool having a taper projection on one side which fits a taper hole in the holder. The holder, if made this way, should not be hardened; at least the walls of the taper hole should not be hard.

When the tool is to be used in the automatic screw machine the holder is usually of a different design than if for a hand machine. Especially is this the case when heavy work, or work which would bring a great strain on the tool, is to be

done. The more common holder is that shown in Fig. 20, and is made in the form of an angle iron. The bottom of the holder is usually provided with a tongue which fits in the slot in the tool rest. The fixture is securely fastened to the rest by means of bolts, as shown. If the head of the bolt projecting beyond the surface of tool is objectionable it may be made flush, Fig. 21. When extremely heavy cuts are to be taken the form of holder described above may not hold the tool securely, and in such cases it is often considered advisable to make a holder like that shown in Fig. 22. The tool should have a square thread in the bore, the pitch of which is 1-5 or 1-6 inch (that is 5 or 6 threads per inch) right or left hand, according to which side of the holder it is to be located on when in use, so that the tool will have a tendency to tighten when cutting. To get a fine adjustment the thread in the holder must be of finer pitch than that in the tool, and of the same hand. It is obvious that extreme care must be exercised when cutting the thread in the holder, to insure its being at right angles with the face against which the tool is to rest.

Milling Machine Cutters.

No one branch of machine shop work has made greater strides than the process of removing stock by means of rotating cutters used in connection with milling machines. The progress has been especially marked since the introduction of grinding machinery and of wheels made of abrasive materials, making it possible to leave the cutters as hard as is consistent with toughness.

The introduction of formed cutters has made practical the manufacture of intricate forms which can be ground on their cutting faces without changing their shape. The writer can remember as a boy making cutters of irregular shape which,

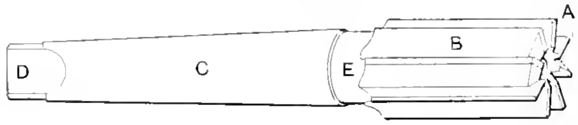


Fig. 23

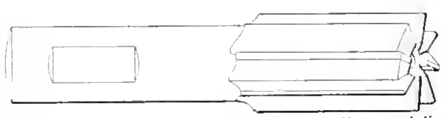


Fig. 24

after hardening, were softened sufficiently while tempering to permit of their being sharpened when dull by scraping with a three-cornered scraper, hardened very hard. This operation could only be repeated a few times before it was necessary to anneal them and re-work to shape.

The use of formed mills makes it possible to mill intricate shapes which it was formerly necessary to produce by planing; and much more cheaply.

End Mills. This form of milling machine cutter is provided with a shank which is held in a collet or in a chuck, and in many shops this is called a shank mill. Generally speaking the shanks are made tapering, as shown in Fig. 23, and the collet has a corresponding tapered hole to receive the shank. In some cases, however, the shanks are made straight, as in Fig. 24, and then the collet has a straight hole of the size of the shank. The cutter is held in place by means of a setscrew, or the shank may be held in a chuck, although this is not a common method. The collet referred to is used to save stock, as otherwise it would be necessary to use steel sufficiently large to make a shank of the size of the hole in the milling machine spindle.

End mills are made right- and left-handed. The one shown in Fig. 23 is called a left-hand mill; a right-hand mill has its teeth cut so as to necessitate running the cutter in the opposite direction.

For the general run of work steel containing 1¼ per cent. carbon answers nicely for mills of this description. If extreme care is taken when hardening, steel containing a higher percentage of carbon may be used and will be found more satisfactory. The stock should be enough larger than the cutting portion of mill to permit turning off the decarbonized surface of the steel. When the ends are faced to length, and a chip has been turned off, to clean the surface, one end is run in the steadyrest and the center is cut as at *A*, Fig. 23. The object of recessing the end is to furnish a cavity for the cutter to enter that is used to cut the teeth on the end. It also facilitates the operation of grinding the teeth on the end.

If the mill is to have a tenon on the end, as indicated at *D*, this may be turned to size and milled, as shown. It should be a trifle (1-32 inch) thinner than the width of the center key slot in the collet. The tapered portion, *C*, is made sufficiently large to allow of grinding after the cutter is hardened, in order to insure its running true. The cutting portion, *B*, is also turned a trifle (say .01 inch) large, to provide

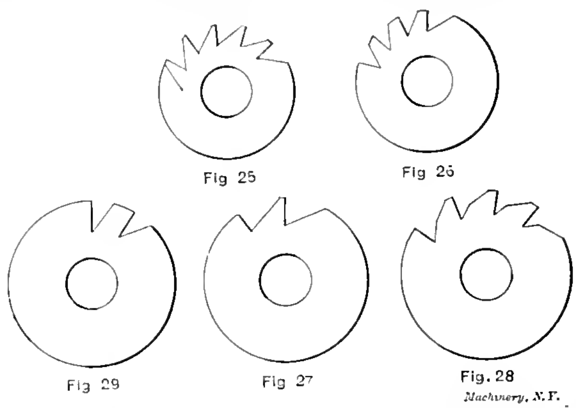


Fig 25 Fig 26
Fig 29 Fig 27 Fig. 28

for grinding; and the portion *E* should be 1-32 inch smaller than the large end of the taper, unless specific instructions as to size are given on the drawing.

End mills have their teeth cut both straight and spiraling, according to the uses to which they are to be put. To insure a strong tooth, or one that will resist the strain incident to cutting, due regard must be paid to its shape. Not only must the tooth be strong but it must be cut deep enough to hold chips and not clog. A thin tooth, like that shown in Fig. 25, will spring into the stock when cutting, which puts an additional strain on the tooth and causes it to break. The tooth must not be too broad across the top (Fig. 26) or it will not be possible to grind it satisfactorily. Fig. 27 shows a cutter whose teeth are strong and deep enough to hold the chips and yet work in a satisfactory manner. At times it is desirable to have cutter teeth of the form shown in Fig. 28. This is done by first cutting around with an angular mill that will produce a tooth like that in Fig. 29, and then turning the index head and finishing the tooth to the shape shown in Fig. 28. This tooth answers nicely when the cutter is to be subjected to great strain, as when cutting irregular surfaces, or where it will come in contact with corners of the work.

The number of teeth to cut in an end mill cannot be stated arbitrarily; this will depend altogether on circumstances. There is a tendency in many shops to make cutters having too many teeth rather than too few.

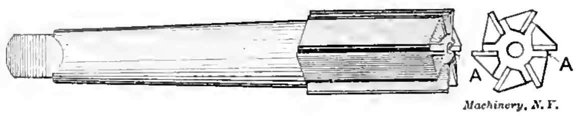


Fig. 30.

When it is necessary to cut into the surface of a piece of work with the end of the mill and then feed along, as in die work, internal cams, etc., the teeth are sharpened or given clearance, on the inside, and so are able to cut a path from the point where the mill is sunk into the work. The teeth being very coarse allow of heavy cuts. This is especially the case when cast iron is the material being machined. After cutting the teeth on the end of the mill a thin metal-splitting saw of comparatively small diameter should be run through close to the face of each tooth, making the cut shown in Fig. 30 at *A*. This cut is to permit backing off the inner edge of the tooth, which gives the mill a cutting tooth on the inside as well as on the outside, and allows it to cut away the projection made when the mill was fed into the work.

For end mills with spiral teeth it will be necessary to have

a spiral that will cause the shank of the mill to stay in the collet rather than draw it out. The subject of spiral teeth will be considered in another part of this article, under milling machine cutters with spiral teeth.

T-Slot Cutters. It is customary to provide with T-slots all machines which are to hold the work by means of bolts. These slots were formerly cut on a planer, with a tool like that in Fig. 31. When many slots are to be cut this is an expensive method and has been almost entirely superseded by the use of a milling cutter made especially for this pur-

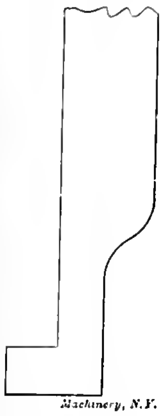


Fig. 31.

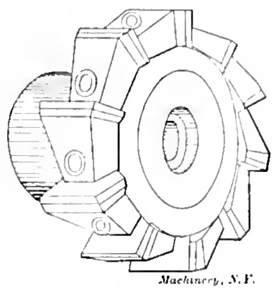


Fig. 38.

Fig. 40.

pose, and termed T-slot cutter, Fig. 32. This form of cutter is made 1-32 inch larger than its designated size, to allow for grinding; that is, a ¾-inch T-slot cutter would be ¾ inch + 1-32 inch diameter when ready for use, unless the T-slot is to be cut to given dimensions. Teeth must be provided on the sides of this form of mill, as shown in Fig. 32.

It is advisable to harden mills of this description the entire length of the necked portion marked *B*, especially if the neck is of small diameter. Draw the neck to a blue color when tempering, and the cutting portion to a straw color. The teeth of T-slot cutters should be coarse and of a form that insures the greatest strength possible, allowing of course sufficient space between teeth to accommodate chips.

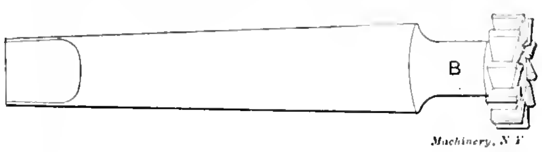


Fig. 32.

Fly Cutters. This is the simplest form of milling machine cutter, and is often used when but one piece, or a limited number of pieces of irregular shape, is to be produced. It recommends itself for experimental and similar work, on account of cheapness and the ease with which it can be made. As shown in Fig. 33 the cutter, which is single, is held in a holder known as a "fly cutter arbor." This cutter is given its shape and clearance by several methods. If the shape is not very intricate it may be produced by filing. To make a fly cutter from a forming tool the square piece of steel for the cutter is held in the fly cutter arbor and the shape produced by the forming tool. To get the necessary clearance the face

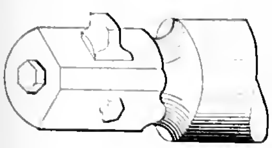


Fig. 33

Fig. 34

Fig. 35

Fig. 36

of the tool is set somewhat back of the center, as shown in Fig. 34. This is readily done as the stock used for the cutter need not be as large as the hole in the arbor. It is held in position by pieces of steel used as blocks, and is then securely fastened by setscrews provided with the arbor. After being hardened the cutter is placed in the holder so that the face is radial, Fig. 35, and it will be found to have the necessary clearance.

A commonly used method for getting the desired clearance consists in placing the face of the stock to be used for the cutter radial but locating the outside as near the arbor as is practical, as shown by dotted lines *A*, Fig. 36. After forming and hardening it is set to cut in the position marked *B*, and it will be found to have the necessary clearance.

While fly cutters are very useful for certain purposes they are seldom employed where many pieces are to be machined. Having but one cutting tooth they necessarily cut very slowly.

Face Milling Cutters. This form of cutter is used quite extensively on certain classes of work and is especially valuable for use on surfaces too large to be machined with the ordinary type of cutter held on a milling machine arbor. For work to be milled with a cutter held on an arbor, as shown at *A*, Fig. 37, it is necessary to use a cutter whose diameter is twice the size of the surface being machined, plus the diameter of the arbor. When a face mill is used, as at *B*, the diameter of the cutter need only exceed the width of surface being milled by a trifle.

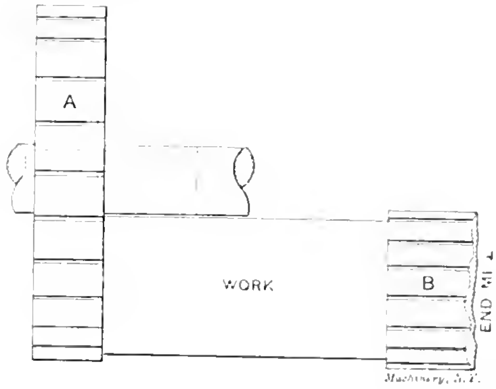


Fig. 37

For large work mills having inserted teeth are used, Fig. 38. The body of the mill is made of machinery steel, or cast iron, and the teeth of tool steel, hardened, or else of high-speed steel. When the machine employed is sufficiently strong to resist the extra strain incident to high speeds, use high speed steel in making the teeth, for the amount of work produced per machine may thus be more than doubled. The advantages claimed for cutters having inserted teeth are that while the cost of making the first cutters may not be any less than for a solid one, the teeth may be renewed when worn out, at a comparatively low cost. Then again it is not, generally speaking, advisable to harden milling machine cutters above 6 inches in diameter in a shop provided with only ordinary facilities for doing work of this character.

Fig. 39

It is considered best practice in most shops to make cutters of this description with taper holes. The arbor, of course, has a corresponding taper and is provided with a key which prevents the cutter turning on the arbor. The arbor is provided with a screw which draws the cutter onto the taper, as will be seen in Fig. 39, while Fig. 40 represents a sectional view of a cutter, showing it recessed to receive the screw head.

If the cut is to extend more than ¾ inch on the face of the mill, the teeth are made spiral; but if the cut does not exceed this width the teeth are made straight, mills with straight teeth being less costly.

The various methods used to hold the teeth in place will be considered in the next article, which will deal with milling machine cutters in general.

* * *

The increase in mechanical efficiency of engines with forced lubrication has been clearly shown by recent engines built by the B. F. Sturtevant Co. at Hyde Park, Mass., and fitted with a forced pump lubricating system. An increase of from 8 to 10 per cent is shown, and with their latest type of vertical single engines a mechanical efficiency averaging 94 per cent.

THE DEVELOPMENT AND USE OF HIGH-SPEED TOOLS.*

The high-speed steels of the present day are combinations of iron and carbon with: (1) Tungsten and chromium, (2) Molybdenum and chromium, (3) Tungsten, molybdenum and chromium.

Influence of Carbon.—A number of tool steels were made by the Armstrong Whitworth Co. with the carbon percentage varying from 0.4 per cent to 2.2 per cent, and the method of hardening was to heat the steel to the highest possible temperature without destroying the cutting edge, and then rapidly cooling in a strong air blast. By this simple method of hardening it was found that the greatest cutting efficiency is obtained where the carbon ranges from 0.4 per cent to 0.9 per cent, and such steels are comparatively tough. Higher percentages are not desirable because great difficulty is experienced in forging the steels, and the tools are inferior. With increasing carbon contents the steel is also very brittle, and has a tendency to break with unequal and intermittent cutting.

Influence of Chromium.—Having thus found the best carbon content to range from 0.4 per cent to 0.9 per cent, the next experiments were made to ascertain the influence of chromium varying from 1.0 per cent to 6.0 per cent. Steels containing a low percentage are very tough, and perform excellent work on the softer varieties of steel and cast-iron, but when tried on harder materials the results obtained were not so efficient. With an increased content of chromium the nature of the steel becomes much harder, and greater cutting efficiency is obtained on hard meterials. It was observed that with an increase of chromium there must be a decrease in carbon to obtain the best results for such percentage of chromium.

Mention may here be made of an interesting experiment to ascertain what effect would be produced in a rapid steel by substituting vanadium for chromium. The amount of vanadium present was 2.0 per cent. The steel readily forged, worked very tough, and was hardened by heating to a white heat and cooling in an air blast. This tool when tried on medium steel stood well, but not better than the steel with the much cheaper element of chromium in it.

Influence of Tungsten.—This important element is contained in by far the greater number of the present high-speed steels in use. A number of experiments were made with the tungsten content ranging from 9.0 per cent to 27.0 per cent. From 9.0 per cent to 16.0 per cent the nature of the steel becomes very brittle, but at the same time the cutting efficiency is greatly increased, and about 16.0 per cent appeared to be the limit, as no better results were obtained by increasing the tungsten beyond this figure. Between 18.0 per cent and 27.0 per cent it was found that the nature of the steel altered somewhat, and instead of being brittle, it became softer and tougher, and whilst such tools have the property of cutting very cleanly, they do not stand up so well.

Influence of Molybdenum.—The influence of this element at the present time is under investigation, and our experiments with it have so far produced excellent results, and it was found that where a large percentage of tungsten is necessary to make a good rapid steel, a considerably less percentage of molybdenum will suffice. A peculiarity of these molybdenum steels is that in order to obtain the greatest efficiency they do not require such a high temperature in hardening as do the tungsten steels, and if the temperature is increased above 1,800 degrees F. the tools are inferior, and the life shortened.

Influence of Tungsten with Molybdenum.—It was found that the presence of from 0.5 per cent to 3.0 per cent molybdenum in a high tungsten steel slightly increased the cutting efficiency, but the advantage gained is altogether out of proportion to the cost of the added molybdenum.

Influence of Silicon.—A number of rapid steels were made with silicon content varying from a trace up to 4.0 per cent. Silicon sensibly hardens such steels, and the cutting efficiency on hard materials is increased by additions up to 3.0 per cent. By increasing the silicon above 3.0 per cent, however, the cutting efficiency begins to decline. Various experiments were made with other metals as alloys, but the results obtained were not sufficiently good by comparison with the above to call for comment.

An analysis of one of the best qualities of rapid steels produced by the author's firm (Armstrong, Whitworth Co.) is as follows: "A.W." Steel.—Carbon, 0.55 per cent; Chromium, 3.5 per cent; Tungsten, 13.5 per cent.

What may be said to determine a high-speed steel, as compared to an ordinary tool steel, is its capability of withstanding the higher temperatures produced by the greatly increased friction between the tool and the work due to the rapid cutting. An ordinary carbon steel containing, say, 1.20 per cent carbon when heated slightly above the critical point and rapidly cooled by quenching in water becomes intensely hard. Such a steel gradually loses this intense hardness as the temperature of friction reaches, say, 500 degrees F. The lower the temperature is maintained the longer will be the life of the tool, so that the cutting speed is very limited. With rapid cutting steels the temperature of friction may be greatly extended, even up to 1,100 degrees F. to 1,200 degrees F., and it has been proved by experience that the higher the temperature for hardening is raised above the critical point and then rapidly cooled, the higher will be the temperature of friction that the tool can withstand before sensibly losing its hardness. The high degree of heating (almost to melting point, in fact) which is necessary for hardening high-speed steel forms an interesting study in thermal treatment and is indeed a curious paradox, quite inverting all theory and practice previously existing. In the case of hardening ordinary carbon steels very rapid cooling is absolutely necessary, but with high-speed steels the rate of cooling may take a considerably longer period, the intensity of hardness being increased with the quicker rate of cooling.

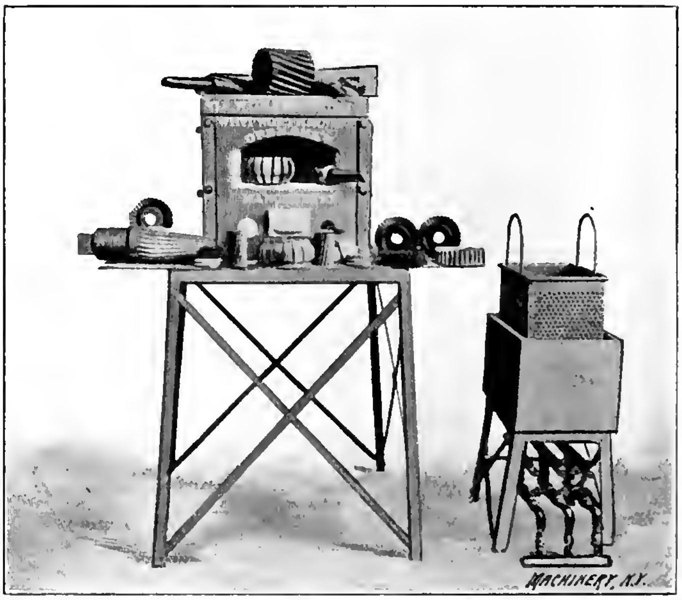


Fig. 1. Muffle Furnace for Hardening Milling Cutters made of High-speed Steel; also Tank and Dipping Cage for Tempering them in Oil.

Heat Treatment of High-speed Steel.

Turning now to some points in the heat treatment of high-speed steel, one of the most important is the process of thoroughly annealing it after working into bars. Accurate annealing is of much value in bringing the steel into a state of molecular uniformity, thereby removing internal strains that may have arisen, due to casting and tilting, and at the same time annealing renders the steel sufficiently soft to enable it to be machined into any desired form for turning tools, milling cutters, drills, taps, screwing dies, etc. The annealing of high-speed steel is best carried out in muffle furnaces designed for heating by radiation only, a temperature of 1,400 deg. F. being maintained from twelve to eighteen hours according to the section of the bars of steel dealt with. Further advantage also results from careful annealing by minimizing risks of cracking when the steel has to be reheated for hardening. In cases of intricately-shaped milling tools having sharp square bottom recesses, fine edges, or delicate projections, and on which un-

* Abstract of paper read by Mr. J. M. Gledhill before the Iron and Steel Institute, October, 1904.

equal expansion and contraction are liable to operate suddenly, annealing has a very beneficial effect toward reducing cracking to a minimum. Increased ductility is also imparted by annealing, and this is especially requisite in tools that have to encounter sudden shocks due to intermittent cutting, such as planing and slotting tools, or others suddenly meeting projections or irregularities on the work operated on.

In preparing high-speed steel ready for use the process may be divided principally into three stages: forging, hardening, and grinding. It is, of course, very desirable that high speed steel should be capable of attaining its maximum efficiency and yet only require treatment of the simplest kind, so that an

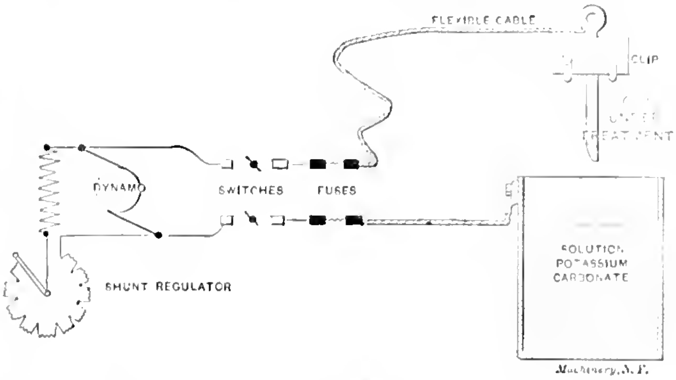


Fig. 2. Apparatus for Hardening Tools Electrically in a Bath of Potassium Carbonate.

ordinarily skilled workman may easily deal with it, otherwise the preparation of tools becomes an expensive and costly matter, and materially reduces the advantages resulting from its use. Fortunately, the treatment of the rapid steel produced by the author's firm is of the simplest; simpler in fact than ordinary carbon steels or the old self-hardening steels. Great care had to be exercised in the heating of the latter steels, for if either were heated above a blood-red heat, say 1,600 degrees F., the danger of impairing their efficiency by burning was considerable; whereas with the high-speed steel, heating may be carried to a much higher temperature, even up to melting point, it being practically impossible to injure it by burning. The steel may be raised to a yellow heat for forging, say 1,850 degrees F., at which temperature it is soft and easily worked into any desired form, the forging proceeding until the temperature lowers to a good red heat, say 1,500 degrees F., when work on it should cease and the steel be reheated.

In heating a bar of high-speed steel preparatory to forging (which heating is best done in a clear coke fire) it is essential that the bar be heated thoroughly and uniformly, so as to ensure that the heat has penetrated to the center of the bar, for if the bar be not uniformly heated, leaving the center comparatively cold and stiff, while the outside is hot, the steel will not draw or spread out equally, and cracking will probably result. A wise rule in heating is to "hasten slowly."

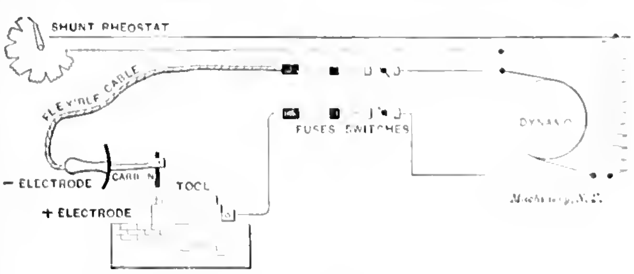


Fig. 3. Apparatus for Hardening Tools by the Electric Arc.

It is not advisable to break pieces from the bar while cold, the effect of so doing tending to induce fine end cracks to develop which ultimately may extend and give trouble; but the pieces should be cut off while the bar is hot, then be reheated as before and forged to the shape required, after which the tool should be laid in a dry place until cold.

The temperature for hardening high-speed steel varies somewhat according to the class of tool being dealt with. When hardening turning, planing, or slotting tools, and others of similar class, the point or nose of tool only should be gradually raised to a white melting heat, though not necessarily melted, but even should the point of the tool become to a greater or less extent fused or melted no harm [illegible]. The tool should then be immediately placed in an a[illegible] and cooled down, after which it only requires grinding an[illegible] ready for use. Another method which may be descr[illegible] preparing the tools is as follows: Forge the tools as before and when quite cold grind to shape on a *dry* stone or emery wheel, an operation which may be done with the tool fixed in a rest and fed against the stone or emery wheel by a screw, no harm resulting from any heat developed at this stage. The tool then requires heating to a white heat, but just short of melting, and afterward completely cooling in the air blast. This method of first roughly grinding to shape also lends itself to cooling the tools in oil, which is specially efficient where the retention of a sharp edge is a desideratum, as in finishing tools, capstans and automatic lathe tools, brass-workers' tools, etc. In hardening where oil cooling is used the tools should be first raised to a white heat, but without melting, and then cooled down either by air blast or in the open to a bright red heat, say 1,700 degrees F., when they should be instantly plunged into a bath of rape or whale oil, or a mixture of both.

Referring to the question of grinding tools, nothing has yet been found so good for high-speed steels as the wet sandstone, and the tools ground thereon by hand pressure, but where it is desired to use emery wheels it is better to roughly grind the tools to shape on a dry emery wheel or dry stone *before* hardening. By so doing the tools require but little grinding after hardening, and only slight frictional heating occurs, but not sufficient to draw the temper in any way, and thus their cutting efficiency is not impaired. When the tools are ground on a wet emery wheel and undue pressure is applied, the heat generated by the great friction between the tool and the emery wheel causes the steel to become hot, and water playing on the steel while in this heated condition tends to produce cracking.

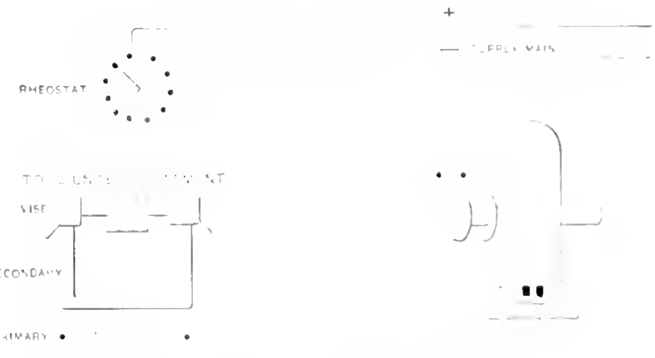


Fig. 4. Apparatus for Tempering Milling Cutters Electrically.

With regard to the hardening and tempering of specially formed tools of high-speed steel, such as milling and gear cutters, twist drills, taps, screwing dies, reamers, and other tools that do not permit of being ground to shape after hardening, and where any melting or fusing of the cutting edges must be prevented, the method of hardening is as follows:

A specially arranged muffle furnace heated either by gas or oil is employed, and consists of two chambers lined with fire clay, the gas and air entering through a series of burners at the back of the furnace, and so under control that a temperature up to 2,200 degrees F. may be steadily maintained in the lower chamber, while the upper chamber is kept at a much lower temperature. Before placing the cutters in the furnace it is advisable to fill up the hole and keyways with common fire-clay to protect them. The cutters are first placed upon the top of the furnace until they are warmed through, after which they are placed in the upper chamber, Fig. 1, and thoroughly and uniformly heated to a temperature of about 1,500 degrees F., or, say, a medium red heat, when they are transferred into the lower chamber and allowed to remain therein until the cutter attains the same heat as the furnace itself, [illegible] about 2,200 degrees F. and the cutting edges become a bright yellow heat, having an appearance of a glazed or greasy surface. The cutter should then be withdrawn while the edges are sharp and uninjured, and revolved before an air blast until the red heat has passed away, and then while the cutter is still warm —that is, *just* permitting of its being handled—it should be plunged into a bath of tallow at about 200 deg. F. and the

temperature of the tallow bath then raised to about 520 degrees F., on the attainment of which the cutter should be immediately withdrawn and plunged in cold oil.

Of course there are various other ways of tempering, a good method being by means of a specially arranged gas-and-air stove into which the articles to be tempered are placed, aud the

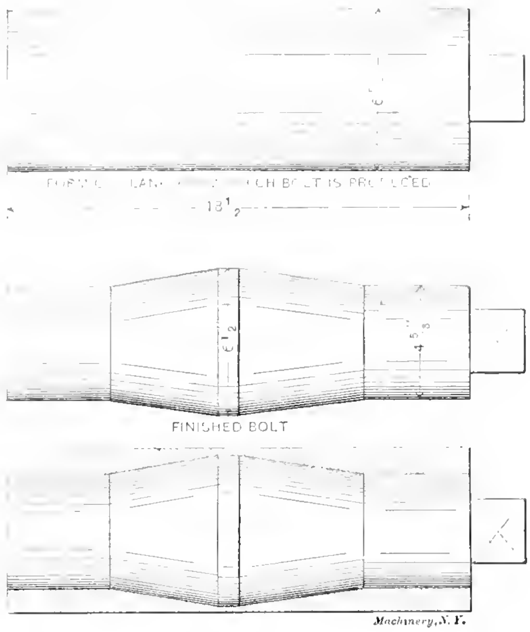


Fig. 5. Showing Stock and Finished Armor Bolts Turned at a Cutting Speed of 160 feet per minute. Mean Depth of Cut, 3-4 inch; Traverse, 1-32 inch Reduction in Weight, 62 pounds. Forty of these Bolts were Turned in ten hours with "A. W." Steel.

stove then heated up to a temperature of from 500 degrees F. to 600 degrees F., when the gas is shut off and the furnace with its contents allowed to slowly cool down.

Another method of heating tools is by electrical means, by which very regular and rapid heating is obtained, and where electric current is available, the system of electric heat-

tank. The tool to be hardened is held in a suitable clip to ensure good contact. Proceeding to harden the tool the action is as follows:

The current is first switched on, and then the tool is gently lowered into the solution to such a depth as is required to harden it. The act of dipping the tool into the alkaline solution completes the electric circuit and at once sets up intense heat on the immersed part. When it is seen that the tool is sufficiently heated the current is instantly switched off, and the solution then serves to rapidly chill and harden the point of the tool, so that no air blast is necessary.

Another method of heating the point of tools is by means of the electric arc, the heating effect of which is also very rapid in its action. The general arrangement and form of the apparatus here employed being as illustrated in Fig. 3.

The tool under treatment and the positive electrode are placed on a bed of non-conducting and non-combustible material and the arc started gradually at a low voltage and steadily increased as required, by controlling the shunt rheostat, care being taken not to obtain too great a heat and so fuse the end of the tool. The source of power in this case is a motor generator consisting of a continuous-current shunt-wound motor at 220 volts, coupled to a continuous-current shunt-wound dynamo at from 50 to 150 volts. Arcs from 10 to 1,000 amperes are then easily produced and simply and safely controlled by means of the shunt rheostat.

Tempering.—Electricity is also a very efficient and accurate means of tempering such forms of tools as milling, gear, hobbing and other similar cutters, also large hollow taps, hollow reamers, and all other hollow tools made of high-speed steel, where it is required to have the outside or cutting portion hard, and the interior soft and tenacious, so as to be in the best condition to resist the great stresses put upon the tool by the resistance of the metal being cut, and which stresses tend to cause disruption of the cutter if the hardening extends too deep. By means of the apparatus illustrated in Fig. 4 this tempering or softening of the interior can be perfectly and quickly effected, thus bringing the cutter into the best possible condition to perform rapid and heavy work.

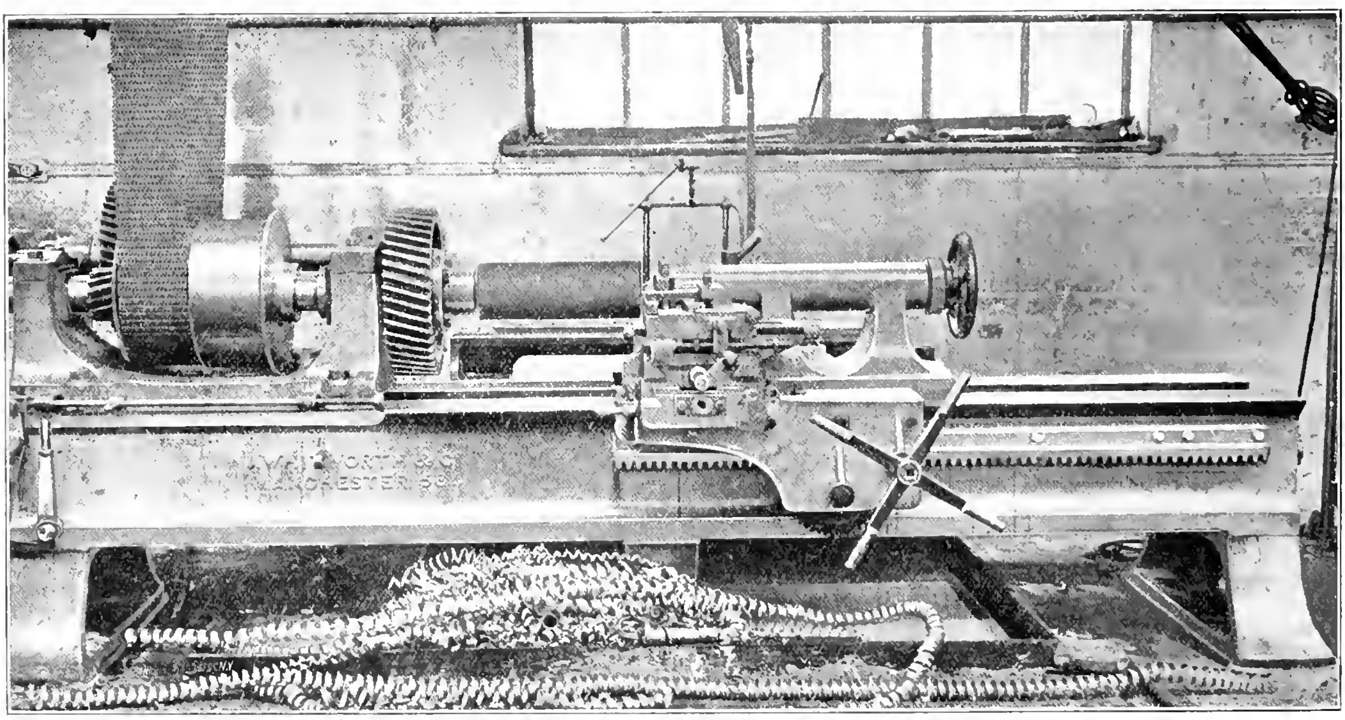


Fig. 6. Lathe used for Turning Armor Bolts. Removed 2,480 pounds of Steel Chips in ten hours.

ing is quick, reliable, and economical. A brief description of this kind of heating may be of interest. One method adopted for electrically heating the points of tools, and the arrangement of apparatus is shown in Fig. 2. It consists of a cast-iron tank, of suitable dimensions, containing a strong solution of potassium carbonate together with a dynamo, the positive cable from which is connected to the metal clip holding the tool to be heated, while the negative cable is connected direct on the

Tempering of hollow cutters, etc., is sometimes carried out by the insertion of a heated rod within the cutter and so drawing the temper, but this is not entirely satisfactory, or scientific, and is liable to induce cracking by too sudden heat application, and further because of the difficulty of maintaining the necessary heat and temperature required, and afterward gradually lowering the heat until the proper degree of temper has been obtained. In electrical tempering these difficulties

are overcome, as the rod is placed inside the cutter quite cold, and the electric current gradually and steadily heats up the rod until the correct temperature is reached. Then it can be held at such temperature as long as is necessary, and the current can be gradually reduced until the articles operated on are cold again, and consequently the risk of cracking by too sudden expansion and contraction is reduced very greatly. The apparatus used is very simple, as will be seen by reference to Fig. 4. It consists of a continuous-current shunt wound

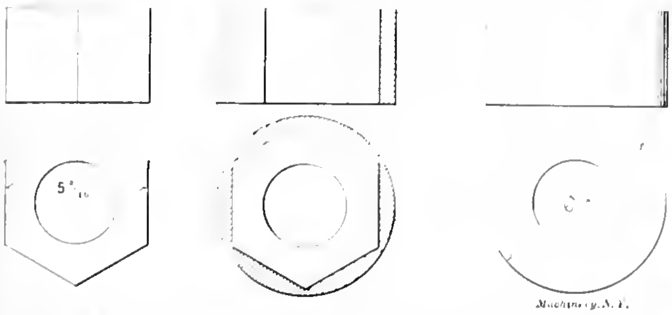


Fig. 7. Examples of Rapid Work with High-speed Milling Cutters. Speed of Cutter, 150 feet per minute; Maximum Depth of Cut, 1 1-2 inches; Reduction in Weight, 7 1-2 pounds; 90 Sleeves produced in ten hours. Total Weight of Metal removed, 675 pounds.

motor directly coupled to a single-phase alternating-current dynamo of the revolving field type giving 100 amperes at 350 volts, 50 cycles per second, the exciting current being taken from the works supply main. The power from the alternator is by means of a stepdown transformer, reduced to current at a pressure of 2 volts, the secondary coil of the transformer consisting of a single turn of copper of heavy cross-section, the extremities of which are attached to heavy copper bars carrying the connecting vises holding the mandrel upon which the cutter to be tempered is placed. The secondary induced current, therefore, passes through a single turn coil, through the copper bars and vises and mandrel. Although the resistance of the complete circuit is very low, still, owing to the comparatively high specific resistance of the iron mandrel, the thermal effect of the current is used up in heating the mandrel which gradually attains the required temperature, slowly imparting its heat to the tool under treatment until the shade of the oxide on the tool satisfies the operator. The method

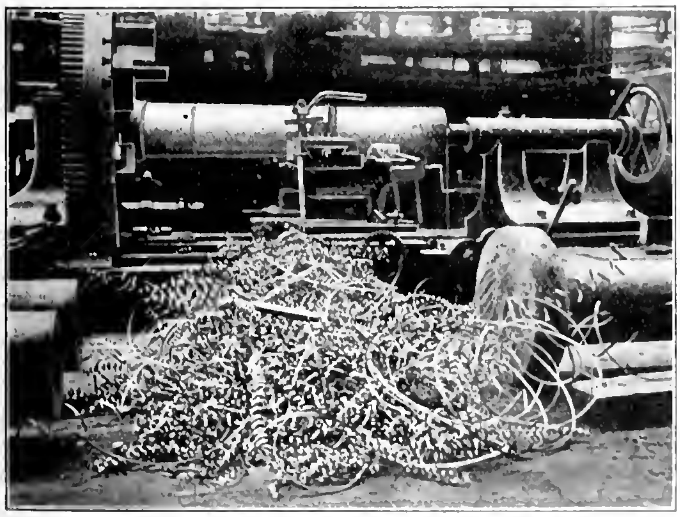


Fig. 8. Chips and Shavings produced in 45 minutes' work, Cutting Speed 150 feet per minute; Depth of Cut, 3-16 inch, Traverse, 1-16 inch

adopted to regulate the heat of the mandrel is by varying the excitation current of the alternator by means of the rheostat. An extremely fine variation and perfect heat control is easily possible by this arrangement.

Some Results of the Use of High-Speed Steel.

It is sometimes contended that on the whole not much advantage or economy results from using high speed steel, but it is easy to prove very greatly to the contrary. That great economy is effected is beyond all doubt, from whichever point of view the question is looked at; for it is not only rapidity of cutting that counts, but the output of machines is correspondingly increased, so that a greater production is obtained from a given installation than was possible when cutting at low speeds with the old tool steel, and the work is naturally produced at a correspondingly lower cost, and of course it follows from this that in laying down new plant and machines the introduction and use of high-speed steel would have considerable influence in reducing expenditure on capital

Fig. 9. Making Hexagon Nuts from Rolled Bars with Cutters of "A. W." High-speed Steel. Ninety Nuts are produced in a day of ten hours

account. It has also been proved that high-speed cutting is economical from a mechanical standpoint and that a given horse power will remove a greater quantity of metal at a high speed than at a low speed, for although more power is naturally required to take off metal at a high than at a low speed (by reason of the increased work done) the increase of that power is by no means in proportion to the large extra amount of work done by the high-speed cutting, for the frictional and other losses do not increase in anything like the same ratio as a high-cutting speed is to a low-cutting speed. A brief example of this may be given in which the power absorbed in the lathe was accurately measured, electrically.

Cutting on hard steel, with 3-16 inch depth of cut, 1-16 inch feed and speed of cutting 17 feet per minute, a power of 5.16 horse power was absorbed, and increasing the cutting speed to 42 feet per minute, the depth of cut and feed being the same, there was a saving in power of 19 per cent for the work being done. Another experiment with depth of cut 3/8 inch and traverse 1-16 inch compared with 1-16 inch traverse and 3-16 inch depth of cut, showed a saving in power of as much as 28 per cent, and still proceeding with a view of increasing the weight of metal removed in a given time the feed was doubled (other conditions being the same) and a still further saving of power resulted. In a word, as in the majority of things, so it is with rapid cutting, the more quickly work can be produced the cheaper the cost of production will be.

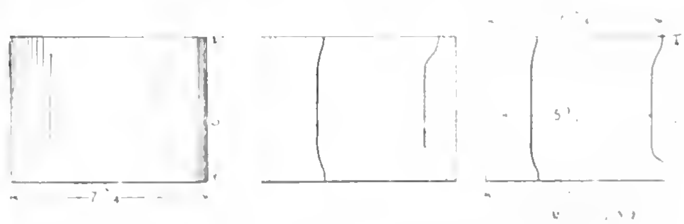


Fig. 10. Sleeves of Armor Bolts. Cutting Speed, 160 feet per minute. Maximum Depth of Cut, 1 1-8 inch. Traverse, 1-32 inch. 60 Sleeves in ten hours

Again as regards economy there is not only a saving effected on the actual machine work, but since the advent of high speed cutting it is now possible, in many instances, to produce finished articles from plain rolled bars, instead of following the old practice of first making expensive forgings and afterward finishing them in the machine. By this practice not only is the entire cost of forging abolished, but the machining on the rolled bar can be carried out much quicker and cheaper in suitably arranged machines, quicker even than the machining of a forging can be done.

A remarkable sample of the gain resulting from the use of

high-speed cutting from rolled bars is illustrated in Fig. 5, the articles in this case being securing bolts, made by the author's firm, for armor plates. Formerly where forgings were first made and then machined with ordinary self-hardening steel, a production of eight bolts per day of ten hours was usual. With the introduction of rapid-cutting steel, forty similar bolts from the rolled bar are now produced in the same time, thus giving an advantage of five to one in favor of quick cutting, and also in addition abolishing the cost of first rough forging the bolt to form; in fact, the cost of forging one bolt alone amounted to more than the present cost of producing to required form twelve such bolts by high-speed machining. The cutting speed at which these bolts are turned is 160 feet per minute, the depth of cut and feed being respectively 3/4 inch and 1-32 inch, the weight of metal removed from each bolt being 62 pounds, or 2,480 pounds in a day of ten hours, the tool being only ground once during such period of work, and from such an example as this it will be at once apparent what an enormous saving in plant and costs results. On the same principle the sleeves (see Fig. 10) for these bolts are produced from bars, sixty being made in one day of ten hours, this being even a greater saving on the old system than the bolt example shows.

An illustration of the lathe on which this work is done is also shown in Fig. 6. It is a 12-inch lathe of special design and strength for rapid and heavy cutting, and has a link driving belt of 7½ inches wide, running at a very high velocity and driven by its own motor, so that the power absorbed can always be observed whether the lathe is running idle or cutting.

Equally remarkable results are obtained by operating on stock bars with high-speed milling cutters, and one example, amongst many, may be cited, which is shown in Fig. 7. Here hexagon nuts for 3¾ inches diameter bolts are made from rolled bars, the cutting speed of milling being 150 feet per minute, giving a production of ninety nuts per day, against thirty formerly. More than ninety nuts could have been produced had the machine been more powerful.

Many other examples of rapid work in planing, milling, drilling, and turning in the Armstrong Whitworth Co.'s and other shops were given by the author.

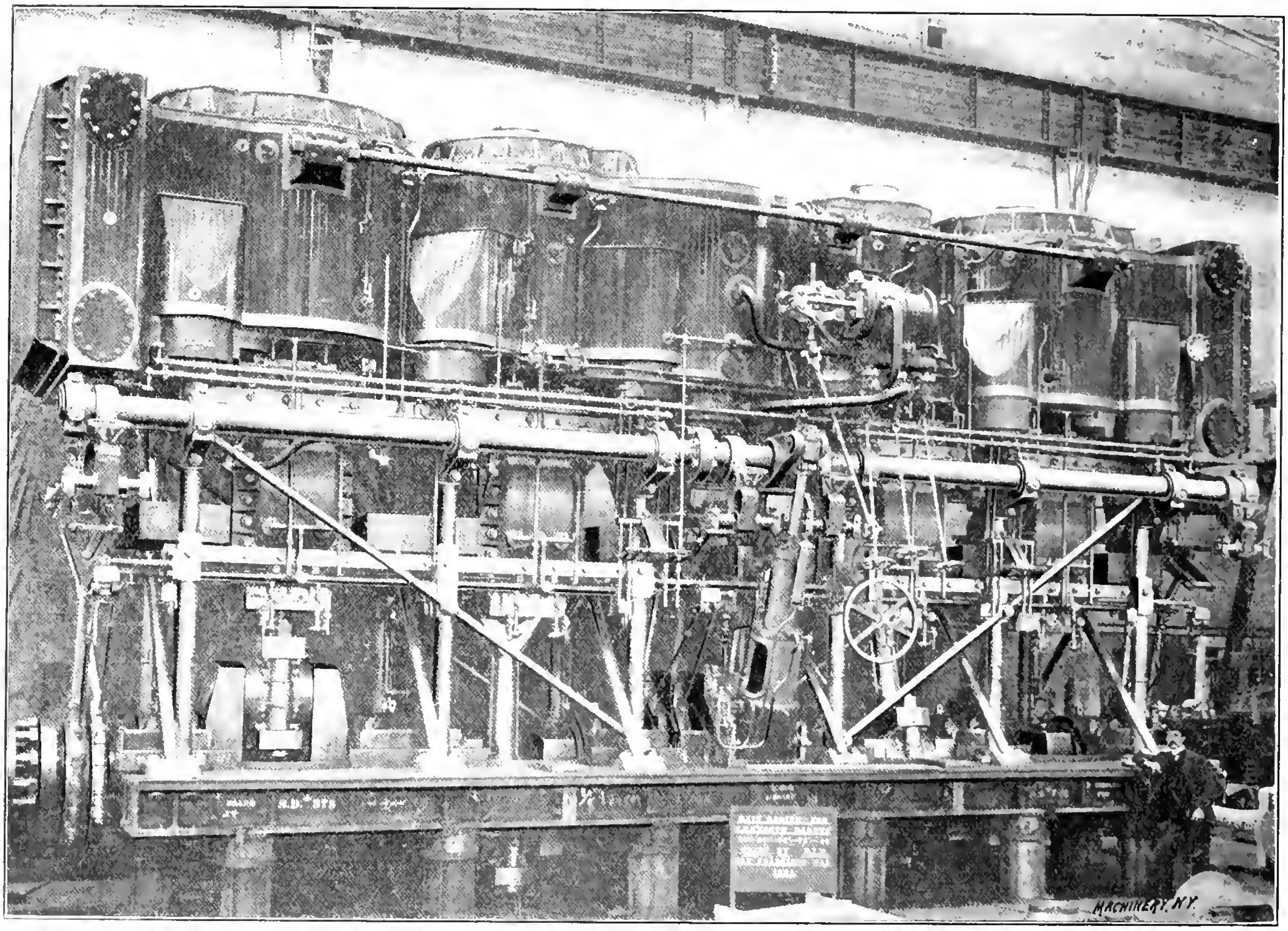
* * *

ENGINES FOR U. S. ARMORED CRUISERS NOS. 6 AND 9, THE CALIFORNIA AND SOUTH DAKOTA.

EARL N. PERCY.

The accompanying half-tone shows an interesting and in some ways wonderful type of steam engine. It is a naval engine of nearly 13,000 indicated horse power, each boat having two, which on the Colorado aggregated 25,000 horse power.

It is a four-cylinder triple-expansion engine with one high-pressure, one intermediate and two low-pressure cylinders. The cylinders are 38½ inches diameter, high-pressure, 63½ inches, diameter of intermediate pressure and diameter of each low-pressure, 74 inches by 48 inches common stroke. The low-pressure cylinders are on each end, and the high-pressure cylinder is forward. These engines are rated at 11,500 horse power each at 120 revolutions, with 250 pounds steam pressure.



One of the Main Engines for the United States Armored Cruiser South Dakota—13,000 I. H. P.

The frame is built entirely of nickel steel rods, to secure lightness, and the bed is of cast steel. Each cylinder is fitted with a liner fastened at the bottom, and provided with a gland on top to allow for expansion. Between each liner and casing is a steam jacket, which is supplied direct from the boilers. The pistons use cast iron snap rings, set out by springs. Watson's packing is used exclusively on all rods. The slide valves are balanced for steam pressure and for weight. The reversing engine is oscillating, being swung on trunnions, thus doing away with crosshead and connecting rod. The main throttle is worked by the large wheel. The auxiliary throttle bypasses the main throttle, and is used for warming up, and operating at slow speeds. The other valves are passovers for warming up, and starting engines. The numerous levers, aside from the reverse, are for the drain cocks.

Separate steam, twin beam airpumps are used. The condenser for each engine has about 14,400 square feet of cooling surface. There are two main exhaust pipes for each engine, four in all, each 27 inches diameter. The main steam pipe for each engine is 13 inches diameter. The condenser takes a 21-inch stream of circulating water thrown by a 10 and 18 x 10-inch compound engine running 200 revolutions per minute. The centrifugal pump runner is 38 inches diameter. Each condenser has 6,280 tubes 5/8 inch diameter, 14 feet long. The shells are 7 feet 5 inches diameter, and the tubes are spaced 15-16 inches apart.

Steam is supplied by sixteen Babcock & Wilcox marine water tube boilers having an aggregate heating surface of 70,941 square feet, and grate surface of 1,600 square feet. Each boiler has a Howden hot air forced draft system, with its own heater and blower engine, and is entirely independent of the rest of the plant except for the steam connections.

The connecting-rods are only 96 inches long, giving a very short connection, with excessive angularity, but making the engine low and compact. The guides are of the slipper type, being on one side only, with overlapping lips. As the engines turn outboard when going ahead, they are operated from the back. While the view is somewhat obstructed, it gives great tactical advantages.

The entire engine is supplied with water service to cool bearings and guides. The shafts and crankpins are hollow, and this space is utilized to force oil into the crank bearings. The eccentrics are oiled by telescope tubes and all other parts by a system of forced drips. All parts can be reached directly if any of the automatic gear fails.

These vessels are of 13,400 tons displacement, and must make upward of 22 knots per hour, the Colorado averaging 22 1/4 knots on her trial trip. They are 502 feet long, 66 feet 6 1/2 inches wide and draw about 25 feet of water. They are armored and have two turrets equipped with 8-inch guns. Besides the four 8-inch breech-loading rifles in the turrets, there will be fourteen 6-inch rapid-fire guns, eighteen 3-inch rapid-fire guns, twelve 3-pounder semi-automatic guns, four 1-pounder heavy semi-automatic guns, two 3-inch field pieces, two machine guns, 0.30 inch caliber, and six automatic guns 0.30 inch caliber.

All wood on these boats is fireproofed. The ship's equipment includes a laundry equipped with one washer, one hydro-extractor, one mangle, two sets of tubs, one tank, dryer, etc., all driven by an electric motor.

* * *

VERTICAL BOILERS IN POWER PLANTS.

The large power plants which have recently been erected in the more populous cities for street railway work, etc., have come to follow certain standard lines of construction. This is especially so in regard to the boiler plant, where the approved arrangement is a double row of water-tube boilers with a center passage between them; above the boilers the economizers; and above all and directly under the roof of the structure, the coal bins, from which the coal descends to the automatic stokers. In a letter to the *Engineering Record*, Mr. George I. Rockwood asks, "Does it pay merely because land is expensive to put 18,000 tons of coal into a bunker 100 feet high in the air, on top of boilers of great weight in themselves, if a boiler house of only one story and of only 3,000 brake horse power can be built for $33.30 per boiler horse power, and occupies but 1.28 square feet of land per boiler horse power?"

This was offered in comment on the immense boiler plant of the Rapid Transit Station in New York City, and the 3,000 horse power plant referred to is one recently established at the Atlantic Mills, Providence, R. I., by Mr. Rockwood. In place of water-tube boilers, he used vertical boilers of his own design similar to the Manning type, and the space thus saved enabled him to place the coal bunkers on the floor, with not only a saving in the cost of foundation but in expensive steel work required to support the coal pockets when located above the boilers. Mr. Rockwood figures that the Rapid Transit boiler plant occupies 1.52 square feet of ground area per boiler horse power. This space includes the coal storage, the boilers, pumps, piping and economizers. The Atlantic Mills plant occupies 1.28 square feet per boiler horse power, including everything except the coal bins, but the economizers, boilers, and all the apparatus are on one floor, and the expense of heavy steel construction is avoided, since a building one story high and strong enough simply to support the roof is all that is required.

Before attempting to decide Mr. Rockwood's question, one must form an opinion as to the advantages of horizontal water-tube and vertical boilers. The water-tube boiler is generally conceded to be the safest type extant, and on the whole an extremely satisfactory boiler. The small space occupied by the vertical boiler is so great an advantage that it may be asked, "Are its disadvantages if any, sufficient to offset this saving in space?" In the water-tube boiler the sediment is deposited in a mud drum, well out of the way of the hot gases, and circulation of the water is rapid; there is no probability of burning out any of the tubes. In the upright boiler, however, the tube sheet is directly over the fire, and is certain to be covered to a greater or less extent with sediment and scale. In this respect it is subjected to the same dangers as the horizontal tubular boiler, namely burning out of that part of the boiler which is directly over the fire, provided the sediment and scale are not removed. It is held, however, that the danger from this deposit is not so great in the case of the vertical boiler as in the horizontal boiler. When a section of the shell is overheated in the latter, it must be patched, and the patch and rivets come in the worst possible place for such repairs. With the vertical boiler it is hardly possible for matters to reach so bad a state. When overheating begins, the tubes and tube sheet become weakened to such an extent that leaking at once occurs around the tubes, and if the deposit gathers over the whole tube sheet, there will be a sufficient rush of steam and water to completely extinguish the fire. If, on the other hand, the heating is local, only a small quantity of water will escape and may possibly not be noticed by the firemen until the tubes in that part of the boiler have become burned. In that case they must be renewed, whereas in the former case it will merely be necessary to expand them into the boiler sheet again.

When the boilers of the Atlantic Mill plant were first used, two of them troubled by leaking, and investigation showed a thick deposit of scale, although the boilers had been thoroughly cleaned and washed out with soda water before the fires were lighted. The water was also known to be free from lime, and the explanation of the scale formed was not forthcoming at once. Later it was determined that the deposit was formed of mill scale which came from the new tubes of the boilers. We do not know whether it is common for boiler manufacturers to pickle the boiler tubes in acid before putting in place, but this experience shows the necessity of it. The boilers had been filled with water some days previous and the tubes had undoubtedly rusted slightly. The boilers were to furnish steam for a Westinghouse-Parsons steam turbine. These turbines are governed by a rapidly reciprocating valve which delivers the steam in impulses, and at first the accompanying vibration was transmitted to the piping and boilers which probably shook off the loosened particles of scale, causing the trouble. The result was one of the unexpected things that so often happen, and is apparently an element that must be considered in starting up new boilers under similar circumstances.

* * *

TIMBER PRESERVING PLANT.

The rapid destruction of the great forests of this country has forced upon the railroads the very serious problem of the supply and preservation of timber, and many efforts have been directed toward perfecting processes to preserve the ties from insects and decay. In a recent installation by the Ayer & Lord Tie Co., of Chicago, the timber being treated is placed in air tight cylinders, where it is first subjected to steam under pressure to remove all air from the pores of the wood, after which the air and steam are exhausted by a Deane wet vacuum pump. When all vapor and gases have been removed, creosote is pumped into the tank and forced into the wood by a pressure pump of the Deane duplex type. A Clayton air compressor is next used to force air into the tank, displacing the creosote and returning it to an elevated storage reservoir. This process is said to give as good results as any now employed for tie preservation.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

THE PROGRESS OF THE CONNECTICUT.

The rivalry between the private shipyards of the Newport News Shipbuilding Co. and that of the Government as represented by the New York Navy Yard in the building of the two 15,000-ton battleships *Louisiana* and *Connecticut* was briefly alluded to in the November issue. There is a general public interest in the matter as there is a sentiment abroad that the Government should be in a position to build its own naval vessels, if for no other reason than to make a healthy competition. There is also a general interest in the competitive results, because the Government yard is working under the handicap of an eight-hour day, while the private yards pay less wages for nine hours of service. The disadvantage under which the Government yard works is still greater than indicated by the length of the working days, inasmuch as the employes receive full pay for about seven legal holidays, and fifteen days leave of absence during the year. This makes twenty-two days, or over seven per cent. of the total number of working days in the year for which it pays but receives no service. On the other hand the Government yard pays no interest upon the investments represented by its shops, and it has to earn no dividends, hence whatever the actual cost of the vessel, there will need be nothing added to represent interest charges, or profit.

But it may be a fact that the eight-hour day and the holidays with full pay are no more serious drawback to the Government in the competitive building of battleships than are some of the many red-tape restrictions that are thrown around the operation of its ship yards. In any manufacturing enterprise, a demand for certain materials is certain to arise that could not well be anticipated, and it will be highly desirable to get them with the least possible delay. This the Government yard cannot do. It must go through the formality of advertising for bids and must in general take the lowest bid which may or may not represent the exact product desired. At the present time the New York Navy Yard has no 5/8-inch bolts in its stores, partly owing to an unexpected demand from another quarter, and it will be a matter of some weeks before the supply can be gotten. The private shipyard could and would, if necessary, order a hundred kegs by telegraph, but the New York Navy Yard cannot order a solitary bolt without going through the formality of advertising for bids. To make government work successful it would seem, therefore, imperative to, in some way, modify these restrictions on getting material promptly as required. In general, of course, it is possible to anticipate the main wants for material and provide for them long before they are required, but it is the small matters that cannot always be anticipated that cause vexatious delays.

The progress of the *Connecticut* is satisfactory from the point of view of the amount of work done. The report of the chief naval constructor, Rear Admiral W. L. Capps, states that the *Louisiana* was 54 per cent. completed and the *Connecticut* 49 per cent. at the times of launching, which were some weeks apart, but from what we have personally learned we do not think that all of this difference practically exists. The machinery of the *Connecticut* is well along toward completion, thanks to the efficient superintendence of Captain J. A. B. Smith, who is in charge of the Steam Engineering Department. The propelling engines were completed some months ago, and are now nearly erected in the vessel, although a period of only two months has elapsed since the launching. This quick work is due to an innovation in the matter of shop erection. The usual plan is to only erect the bare engine in the shop with none of the piping and other appurtenances that require so much time for installation on board ship. The engines of the *Connecticut* were erected complete in the shops in all details as far as possible. The water and oil service piping was placed, the sheet steel lagging covers were fitted and the thousand-and-one other matters that require much time and hard labor were done in the shop under the most advantageous conditions. Again, the engines were not taken apart to the extent that is generally the case. The pistons were left in the cylinders, being clamped in the top heads so the pistons did not project much below the stuffing-boxes. The frames were separated in units of six columns each and clamped together so as to be lowered onto the keelson with practically no change in their alignment. In this way the assembling of the engines has been greatly simplified, and because of the careful work done in the shop, practically little fitting has been necessary in the erection.

An encouraging aspect of the work on the *Connecticut* which will go a long way toward settling the matter of profitable competition is the enthusiasm and hearty service of the employes. In the popular mind, unfortunately, "government work" smacks of inefficiency and dilatory ways, but the conditions that may have been notorious in the past, seem no longer to be so much in evidence. It is claimed that the political faith of an employe is not a potent factor in securing place or preferment; all machinists applying for work must register, and as men are required they must be taken on in turn from the registry list. This method, while having the drawback of compelling the officials to give employment to all comers who pass the registry requirements, does not compel them to retain incompetent help, and it shields them, *if they so desire*, from the evils of political preferment. Hence there seems to be no reason why the handling of labor in the Government ship yards cannot be as efficiently accomplished as in private ship yards, if the officials in charge are of the right sort, and in the New York Navy Yard we believe there is as keen a desire on the part of those responsible as in any private concern. There may be some surprises in store for those who claim that the private shipyard is the only place where Government work can be efficiently and cheaply done.

* * *

The first thing a machine-tender must learn is that journals and bearings cannot be run without oil, or that if they are run without it they will not last long. The necessity of lubricant on working surfaces is not, however, confined solely to structures commonly dignified by the name of machines. Many of the ordinary appliances of common use would work much better and last much longer if occasionally a drop of oil was put where it is needed. Even with this conceded there are very few who would ever think of oiling umbrella joints, but it is said to greatly increase their durability. Oiling not only makes the joints work easier but it prevents rust, which, perhaps, is more destructive than the actual wear.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Some astonishing quantities of dust and dirt are reported as having been removed from apparently cleanly carpeted rooms by the vacuum or sucking process, which has previously been alluded to in these columns. The Fifth Avenue Presbyterian Church in New York City, a large edifice, was recently cleaned in this manner, the spoil being thirteen barrels of dirt sucked out of the carpets and crevices in the floors!

According to a statement in the *Philadelphia Record*, a concern has been organized for the utilization of the vast number of pine stumps that encumber the pine lands of Michigan and Wisconsin. The old stumps are subjected to destructive distillation which produces turpentine, tar, charcoal, and other characteristic products, and in addition what is said to be an excellent quality of lubricating oil. The discovery that lubricating oil can be obtained in this manner is new and this will be the first attempt to exploit the process commercially.

The experimental steel tracks laid about two years ago on Murray Street between Church Street and Broadway for the benefit of heavy trucking, have been torn up. The street has been repaved with wooden blocks and the steel rails will not be relaid. The experiment has demonstrated that steel tracks are a failure for city traffic consisting of horse-drawn vehicles. Although the rolling resistance to the wheels is greatly reduced with them, they were found to be a great menace to the horses. Horses frequently slipped and fell, sometimes breaking their legs or otherwise seriously injuring themselves. The use of the steel highway will become practicable only when the horse has been displaced by the self-propelled vehicle.

The *National Provisioner* says that glue, when combined with chromates and exposed to light, loses its solubility in water, and can, therefore, be used as a cement for articles exposed to moisture. The following is a suitable formula: White glue, 5 to 20 parts; water, 20 parts; potassium bichromate, one to two parts; water, 10 parts. Make the solutions of the glue and of the potassium bichromate in separate portions of water, as indicated above, the glue being dissolved by heat; stir in the solution of bichromate; mix well and then pour the mixture into tin boxes and allow it to congeal therein. For use, take a sufficient quantity of the glue, melt in a cup standing in boiling water; place a layer uniformly on the fractured surfaces, press them together, and expose the articles to the sun for a few hours.

A writer in *Sparks* intimates that low-carbon steel, say about .75 to .80 carbon, will harden deeper than high-carbon steel containing 1.30 to 1.35 carbon. Low-carbon steel has a much higher heat conductivity and a lower specific heat than high-carbon steel, and these reasons alone may account for the difference, although it is probable that the difference in the chemical action of the constituents of the two steels is also partly responsible. The heat conductivities of .50 and 1.33 carbon steel are about as 2 to 1; hence a large piece of steel of low carbon will give up its heat in the bath appreciably quicker than one of high carbon. It also has a slightly lower specific heat so that it contains from 1 to 2 per cent. less heat to give up. There is a surprising difference in the thermal conductivity of hard steel, soft steel and wrought iron, the coefficients being 0.062, 0.111 and 0.152 respectively.

One of the interesting applications of concrete is that of using it for setting posts and similar work, which, if set in the ground unprotected, would soon rot away. A wooden post treated with tar and set in a hole on a flat stone and surrounded by a firmly tamped bed of concrete is practically indestructible and will furnish a sound, substantial foundation for years to come. The same plan is used to some extent in setting of trolley poles, especially, when made of iron. The small diameter of the pole does not give the necessary stability to prevent its being racked out of place by the surging of the trolley wire. But if an ordinary hole dug for such a pole is filled with concrete it forms a mass 25 or 30 inches in diameter and of a length equal to the depth of the hole, which is solidly united to the pole, giving the latter several times the stability that it would have if set in earth alone. Moreover, the concrete preserves the iron for practically all time against corrosion, and it might reasonably be expected that poles so set may rust away above ground before the portion protected by concrete is appreciably affected.

From time to time, says a recent consular report, great efforts have been made by manufacturers and other producers to get rid of the middleman in trade, but so far these efforts have been of little avail. This has been particularly the case in Japan, and those manufacturers in America and England who have believed that they could benefit themselves by eliminating middlemen have had some disastrous experiences. Salesmen have been sent to Japan with this object in view, and endeavors were made to open up direct relations with the Japanese consumers. The result oftentimes has been the wasting of valuable time on commercial letters from students, schoolboys, and other irresponsible parties, whose motive in writing was merely that of curiosity or to get catalogues without the remotest idea of ever ordering goods; or orders have been filled from firms of no commercial standing with the obvious result of getting a lot of bad accounts. Theoretically, no doubt, the existence of the middleman is an economic loss, it being true that he produces nothing while he makes his living. Yet in practice it is found that his knowledge of markets and of business gives him a position in the social economy which would be difficult to otherwise fill. In other words he lubricates the wheels of business; machinery works with less friction with the application of oil, although the oil is not absolutely necessary to make the machine work.

Like most great and enduring enterprises Lloyd's had a small beginning. It is now to the world of shipping and marine insurance what the house of Rothschild is to the banking world. Lloyd's dates from the latter part of the reign of Queen Elizabeth, and had its origin in a small coffee house in Tower Street, kept by Edward Lloyd. He was an enterprising man, and through his business contact with seafaring men and merchants enlisted in foreign trade, foresaw the importance of improving shipping and the method of marine insurance. He was the founder of the system of maritime and commercial intelligence which has been developed into its present effectiveness. Before the time of Edward Lloyd maritime insurance in England was conducted by the Lombards, some Italians, who founded Lombard street, but after Lloyd embarked in the business, Britons conducted marine insurance in London. Lloyd's moved to Pope's Head Alley in 1770, and in 1774 removed to the present quarters in the Royal Exchange. In 1871 Lloyd's was incorporated by act of Parliament. This act defined the objects of the society to be: (1) the carrying on of the business of marine insurance by members of the society; (2) the protection of the interests of members of the society in respect of shipping, cargoes, and freights; (3) the collection, publication, and diffusion of intelligence and information with respect to shipping.—*Consular Report.*

In the transactions of the Lake Superior Mining Institute, Mr. James R. Thomson refers to the very difficult conditions under which deep mine hoisting engines operate. For instance, the big Nordberg quadruple engine hoist at Tamarack lifts from an approximate depth of 5,000 feet and makes from eighteen to twenty trips an hour, thus giving the skip or car an average rate of travel of about 35 miles per hour. The work is of such a peculiar nature that compound or triple

expansion engines are unfitted for it. The load consists of the weight of the ore, the weight of the skip and the weight of the rope. This latter weight is greatest when the skip is at the bottom of the shaft, and decreases as it nears the top. The engine must start with the maximum load, attain full speed in six or seven revolutions, and stop short all within, say, one minute, and after a longer or shorter period of idleness must repeat the operation. Lake Superior hoisting experience has fully demonstrated that simple Corliss engines or other engines of automatic variable cut-off give more economical results than fixed cut-off engines. The economy of using compound or triple expansion engines is indefinite and negative. In this connection the Rateau regenerator and steam turbine work a considerable economy in hoisting plants. The main engines exhaust into a closed regenerator and from this the steam supply of a steam turbine exhausting into a vacuum is taken. The turbine drives an electric generator which supplies current for lights, auxiliary apparatus, etc.

An important difference between the construction of wire ropes and hemp ropes is in the laying of the strands. From time immemorial hemp ropes have been made with the twists of the strands opposite to those of the rope, the object, of course, being to prevent unraveling. Wire ropes were originally made in the same way, but a few years ago a construction known as "Lang's lay" was introduced, in which the twists of both the strands of the wire rope are in the same direction. This makes a very important difference in the wear of ropes running over pulleys or sheaves. In a wire rope made like a hemp rope the wear is concentrated on the crowns of the wires where they pass over the top of each strand, since this portion is the one that comes in direct contact with the sheave groove. In the Lang's lay system the crown is not so acute, and a much larger continuous surface of any wire is exposed to the wearing action, that is, the wear is more nearly parallel with the length of the wires. Oiling wire ropes also has a great effect upon their life. Tests made on ropes oiled and unoiled have demonstrated that oiled ropes will give from two to five times the service of those unoiled. But perhaps the greatest factor in the life of a wire rope is the diameter of the sheave over which it runs. If the diameter of the sheave is so small that with ordinary loads the elastic limit of the outer wires of the rope is exceeded every time the rope passes over the sheave its life will be very short. But if the diameter of all sheaves is made at least 40 times that of the rope, its life will be long.

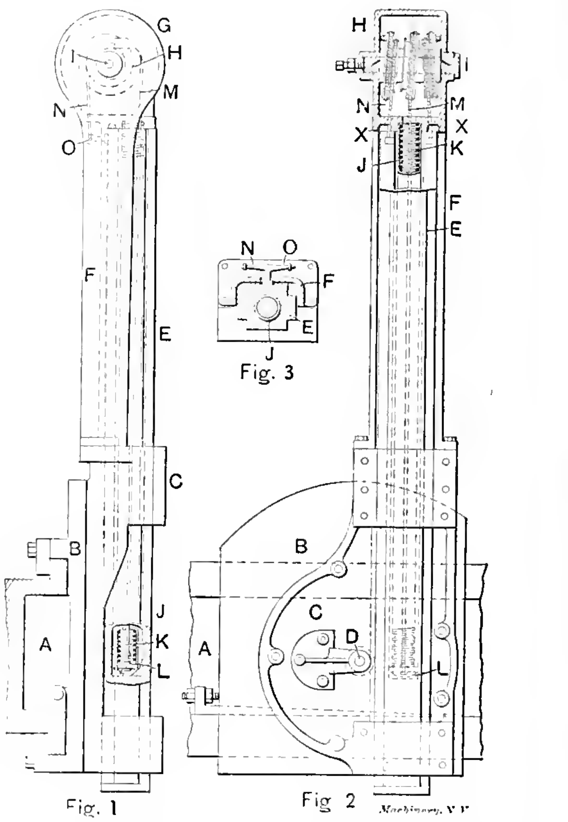
COLD-SOLDERING BANDSAWS.

The brazing of bandsaws with silver solder is an operation requiring considerable skill on the part of the workman, and is an objectionable process because the high temperature necessary to melt the silver solder also draws the temper of the saw at the joint. One of the junctures where the tempered and untempered parts of the blade join is likely to be the point where the next break takes place. Since the breaks are repaired by making lap joints, it follows that a saw becomes shorter and shorter with each repair, and after it has broken a number of times it is shortened so much that it can no longer be used without inserting a new piece, which is objectionable as it makes two joints instead of one to give trouble. A so-called "cold-soldering" process for bandsaws is being exploited by a British concern, that is of interest. By the new process, to which the name "Forkor" has been applied, the joint is made by a method of cold-soldering which is very simple, and requires no apparatus beyond a clamp, spirit lamp, and a pair of broad-faced pliers. The broken ends of the saw are, first of all, filed for a length of from three to four teeth, and then brushed over with a white fluid, the composition of which is at present a secret. The ends, thus coated with the liquid, are warmed by the spirit lamp and rubbed with a stick of solder until the surface is well covered with metal; after which a second layer of the liquid is applied. The ends are then clamped in position and heated again until the solder melts, and are then pressed firmly together with the pliers to squeeze out the excess of solder. After dressing with a file the saw is ready for use.

The advantages of the process, says the *Engineering Review*, are that the temper of the saw is not affected, and should a break occur again it always takes place at the joint. As, therefore, there is no shortening of the saw, it can be used for a much longer period than would be possible were the brazing process used. The time occupied is less than half that necessary for brazing, and, moreover, the saw can be used at once. The cost of making a joint, it is claimed, does not exceed two pence.

BALANCING ARRANGEMENT FOR THE RAMS OF BORING MILLS.

In boring and turning mills the ram or tool holder is usually balanced by means of a cord or chain and weight, but this arrangement is not all that could be desired. To provide a better arrangement the spring balancing device shown in Figs. 1, 2, and 3, has been designed and patented by J. E. Mathewson, of Broadheath, near Manchester. Referring to the illustrations, which with the description are copied from the *Mechanical Engineer*, *A* indicates the cross slide of the machine, the construction of which is well known; *B* is the saddle, and *C* is the ram frame which is pivoted at *D* to the



Balancing Arrangement for the Rams of Boring Mills. See "Machinery," March, 1904.

saddle. *E* is the ram or tool holder which slides in guides in the frame *C*. On the top of the frame *C* is secured a support *F* which supports the box *G* containing the fusee or equivalent equalizing device *H* and the bearings for an axle *I* carrying the same. The ram *E* is hollow, and contains a coiled spring *J* inclosed by a tube *K*. The spring at the top abuts against the under side of the box *G*, and at the bottom rests on a cylindrical block *L* to which the cord or flexible connection *M* is attached. This cord after passing round a fusee is secured to the axle *I* in any convenient manner. On the same axle there are mounted two fusees to which cords *N* are attached, the other ends being secured to arms *O* secured to the back of the ram *E* and extending through a slot in the ram guide, as shown clearly at Fig. 3. As the ram *E* is lowered to bring the tool to its work the axle *I* is rotated by the fusees, and the spring *J* will be compressed through the cylindrical block *L* which is drawn up by its cord *M*, and when the ram is released the spring will return it to its normal position, all of which movements will be clearly understood on reference to the cut.

THE "AUTOPYROPHON."

The "autopyrophon," is a new and simple automatic fire alarm which acts only when a sudden wave of heat is generated in an inclosed space, but is not influenced by a general and evenly high temperature. It is only 3.91 inches high, 2.76 inches broad, and 0.78 inch deep, hence it can be easily fixed anywhere. It consists of a small glass tube bent in the shape of a capital U. This tube, the ends of which are closed, is half filled with mercury, the other upper half containing a highly volatile liquid—for instance, sulphuric ether. One of the upper parts of the glass tube is surrounded by a cover of some non-heat conducting material, so that a sudden rise of temperature affects only the other or free part of the glass tube. In case the temperature rises evenly the whole apparatus is affected and no warning signal is given. If, however, the temperature in the room is suddenly raised, as by the outbreak of a fire, the ether above the mercury in the glass tube, which is unprotected, evaporates, and the pressure of the generated vapors causes the mercury to sink in the tube while it rises in the opposite part. Both parts of the tube are fitted with an electric wire fused into the glass, so that when the mercury stands equally high in both tubes the electric current passes through and the apparatus remains silent, but should a movement of the mercury take place because of a sudden rise of temperature, the electric circuit or contact is impeded, and any kind of electric alarm may be set into motion at any distance and at as many places as required. The apparatus also indicates impediments and interruptions of the electric current. The substances need no renewal and the apparatus acts an indefinite length of time.

The United States Consul-General of Munich, Germany, who was present at a recent demonstration of the device, states that the alarm was raised within eight seconds from the time a small heap of shavings was set on fire in the corner of an ordinary sized room. In this case the apparatus was fixed near the ceiling at the end of the room, opposite that where the shavings were burning. It is calculated that one apparatus which costs about $3 00 is needed for an area of 600 to 800 square feet.

RADIAL STAYBOLTS FOR OIL-BURNING BOILERS.

Railway Master Mechanic, October, 1904.

It has always been a serious problem to maintain locomotive boilers on oil-burning engines owing to the increased intense heat over the coal burning engines. Radial staybolts have been the greatest source of complaint, owing to their leaking, and heads dropping off, and this has compelled the railroads to substitute a bolt which will withstand the enormous strains under oil-burning conditions. With radial staybolts having large button heads, the most trouble experienced has been that the heads drop off after they have been calked but a short time, and also on account of too much iron at a

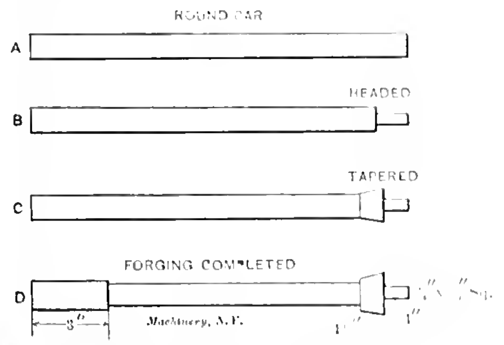


Fig. 1. Successive Steps in the Forging of a Radial Staybolt

point too far away from the water. When the burning oil is shut off the only heat retained in the firebox is in the brick arch and brick walls. This heat is not sufficient unless a good fire is retained, and the boiler is caused to contract very rapidly. The stresses set up by these alternate expansions and contractions are very severe. Unless the handling of the engines, and the keeping of a regular fire are watched very carefully, radial stays, staybolts, and flues give much trouble by getting loose in the holes.

A bolt which is now being used on several railway [illegible]tems is shown by the accompanying line drawings, which [illegible] trate the method of manufacture and application. T[illegible] sheet end of the bolt is made tapering and is cut ve[illegible] to the sheet and hammered up well, thereby making [illegible] as well as steam tight. This bolt up to the present time has been found to meet the requirements better than any other bolt yet tried.

These staybolts are made on the bolt header in the blacksmith shop, and taken direct to the bolt cutter in the boiler shop and finished complete, with the exception of nicking,

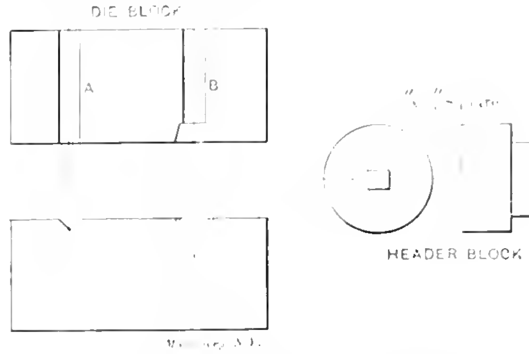


Fig. 2. Die Block and Header Block

which is done in a small chuck lathe, made especially for this purpose. By this process the lathe work is entirely dispensed with.

Taper staybolts, as applied in the San Bernardino shops of the A., T. & S. F. Ry., are of the form shown by Fig. 6, of proper length and diameter to fit holes. The straight thread part is somewhat larger than the body of the bolt, and the taper end has a flare of about one-eighth inch to the inch. A square head is forged at this end to permit the application of a wrench in placing the bolts. These staybolts are forged in an "Ajax" bolt-header, the die block being of the form shown by Fig. 2, with a triangular groove *A* and a countersunk cavity *B*, of shape and dimensions determined by the size of bolts to be headed. The rough bar, of the desired length, is first squared for a distance of one inch at one end. The bolt is then placed in position in the cavity *B* and the heading die-block having a cavity to fit the square head of the bolt, forces the hot bolt into *B*, forming the flared end. The straight end is formed in the usual manner in a straight block. The successive stages of the operation of forging are shown at *A*, *B*, *C*, and *D*, in Fig. 1.

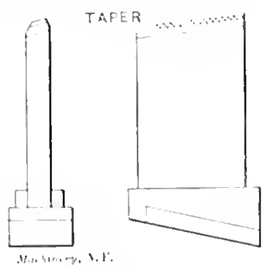
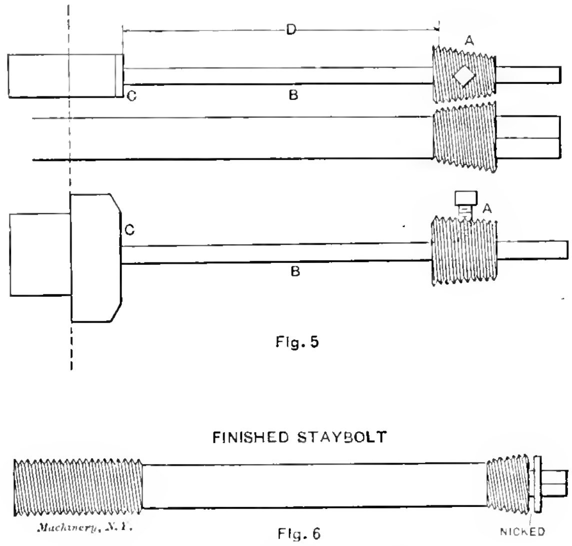


Fig. 3

Fig. 4

The holes in the sheets are tapped with a spindle tap, both threads being cut in one operation. The threads in the two sheets come in perfect alignment and are continuous. In order that the staybolt may follow the threads of the two holes, it is necessary that the threads at both ends of the staybolt be continuous, that is, they must "catch up." These threads are ordinarily chased in a lathe, which insures this condition, but a very simple and effective device makes it possible to cut these threads in a double-headed staybolt cutter; in this way a considerable saving in cost is effected. Tapered dies are made for the bolt cutter of the required sizes, as shown in Fig. 3. The staybolt is placed in the machine with the tapered shank in position for cutting in the dies, held in a simple chuck, shown by Fig. 4. This chuck has a cavity of the proper size to hold the square head of the staybolt, and is rounded and tapered at that end to allow it to follow the staybolt into the dies. This chuck is held in the vise of the machine, and the bolt forced into the dies, which

are regulated in the usual manner for the proper diameter to fit the tapped holes. After the thread has been cut on the tapered end of the bolt, it is placed in the vise, being held at about its middle with the straight shank in position for threading. The dies are, of course, changed to the straight cutting form. Placing the bolt haphazard in the vise will not insure making the threads "follow," and consequently a gage, as shown in Fig. 5, is used to accomplish this end. This gage consists of a block *A*, held on a spindle *B*, by a setscrew. The block *A* is threaded the same as the staybolt, but the taper is reversed to allow the threads to mesh with those of the tapered end when in position. The shoulder *C* is made to rest in the jaws of the vise while holding the staybolt in position for cutting. The distance *D* from the shoulder to the bottom of any thread on the block *A* is set so that it will contain a whole number of threads. For example, if twelve threads per inch are used, *D* would be set in inches and twelfths, etc. This



Method of Locating Staybolt by Gage · Finished Staybolt.

having been done, the distance from the shoulder in the other direction, to the threads on the other end of the staybolt will also be such as to contain a whole number of threads, and the requirement is fulfilled that the threads shall follow, and the staybolt will fit the threads of the holes.

The threads on both ends having been cut, the staybolt is placed in a small cutting-off machine, and nicked just under the head, so that the square head may be easily chipped off after the bolt is in place.

[These staybolts are, we infer, cut in a bolt cutter having a leadscrew which positively controls the movement of the carriage. The gage shown in Fig. 5 must first be adjusted by a staybolt in perfect lead, *i. e.*, one cut in a lathe. It is located in the correct position in the vise by closing the dies on the straight-thread end, and the gage is then set by it; it in turn serves to locate the staybolts as explained.—EDITOR.]

EXPERIMENTAL WORK ON SOLID EMERY WHEELS.

Extract from Paper presented by Mr. T. Dunkin Paret at the May 12, 1904, meeting of the Franklin Institute.

The main cause of bursting emery wheels is heat, but just how heat operates is somewhat of a mystery. The conclusion seems natural that wheels which are poor conductors of heat are the most unsafe. In such wheels the heat created by friction at the circumference works slowly toward the center, and the outer rim expands with speed disproportioned to that of the center. Such expansion might result in cracks transverse to the face and other cracks radiating from face to center. As a matter of observation, the wheels which are unsafe are those whose substance conducts heat easily, and which quickly get hot all through. Such wheels throw off broken edges and irregular chunks, and burst without any definite system of cracks. It follows from this that wheels entirely mineral are not, as a class, so safe as those in which the mineral grains are surrounded and separated by gums, glue, and other organic matter.

The adhesion of metal to the surface of the wheel is also, to some extent, an effect of heat. It may be that wheels with this defect overheat and soften the metal, or the adhesion may be due either to the chemical constitution of the wheel or its physical structure. It is a clearly ascertained fact that free-cutting wheels are not characterized by such adhesion, and that slow-cutting wheels are. It is also evident that as the metal increases in heat the cut (or product) decreases. It is seldom that the end of a ¾-inch by ½-inch cast-iron bar is much reddened by the grinding of a free-cutting wheel, and the edges of the bar are generally clean-cut. Under the same conditions wrought iron gets red-hot for a considerable distance, and flattens out and bends over at the edges.

Many years ago an experimental test machine was built in which the metal was forced against the wheel by a continuous screw feed. As the bar elongated with heat, the pressure increased, and with increased pressure increased heat was generated. Under these conditions the bar became intensely hot and red, and the wheel almost ceased to cut.

Complicated with these questions of heat is the subject of contact area and clearance. The ideal conditions of grinding are those in which wheel and work come in contact on a narrow line. A thin edge of saw steel will be ground rapidly and effectively if pressed against the face of a wheel, while a large flat surface shows little product if pressed against the side. While this is partially due to the vastly greater pressure per square inch in the case of the thin edge, it is also due to the lower heat which results from proper clearance. In the case of the thin edge all debris of wheel and metal fly instantly away, each grain removing its quota of heat. In the case of two large flat surfaces rubbing together the debris is retained (with its included heat) and is bruised into the interstices of the wheel, interfering with its cut. For this reason it is a radical mistake to fit wheel and work in such way that large surfaces are in contact. Cone wheels exactly fitted to corresponding interior metal surfaces (axle surfaces, for instance) are a mistake. So would be large curved grinding blocks, if applied like brakeshoes to the curved face of a carwheel.

The tread of car wheels has long been ground in a practical way with an ordinary disk-shaped emery wheel, the curved exteriors merely touching on a narrow line and affording excellent clearance for wheel and metal debris. For this process, some years ago, was substituted a grinder, in which cup-shaped wheels were used. When the writer of this paper saw that machine in operation, a keg of grain emery stood close at hand, and the operator from time to time dropped some of it between the car wheel and the emery wheel. Questions and further examination brought out the fact that flecks of metal adhered periodically to the emery wheel, and that no proper work could be done until these were removed by the use of the loose grain emery. It was stated that the formation of a single fleck could be heard at the most distant corner of the shop, and this proved true. It was also stated that, when the rims or cutting edges of these wheels were pretty well worn down, such rims were removed entirely, and the wheels transformed into ordinary disk wheels. In this altered form, when the convex exterior of the grinding matter was used instead of its flat side, the wheels did good work and no metal adhered to them.

In the absence of verified data as to the relative cutting capacity of small and large wheels, it is well to point out the manner in which circumference and mass modify the effects of frictional heat. The circumference of a 6-inch wheel is about 19 inches; that of a 36-inch wheel about 113 inches. A wheel 6 inches by 1 inch contains about 28 cubic inches; a wheel 36 inches by 4 inches about 4,000 cubic inches. The standard speed of a 6-inch wheel is 3,600 revolutions per minute; that of a 36-inch wheel 611 revolutions. If a bar ¾ inch by ½ inch is ground on these wheels the heat problem will be different in each case. At the first moment, when bar and wheel come in contact at heavy pressure, intense heat will be developed. In the 6-inch wheel this spot (each and every point of contact) will be heated 3,600 times in a minute, while in the 36-inch wheel it will be heated only 611 times. Though both wheels travel at the same surface speed, the circumference of the 36-inch wheel is so much greater

that it has about six times greater ability to cool. The greater area of its surface causes greater radiation and loss of heat, while that which remains has about 1,000 cubic inches of matter to diffuse itself through, instead of the 28 inches allotted to the 6-inch wheel. If, therefore, frictional heat is an undesirable thing, the advantage of large wheels becomes evident.

There is *apparently* one clear deduction from these facts, and this is that water should be used to prevent the injurious effects of heat. Nothing can be more erroneous than this deduction, and nothing has done more to retard the proper development of grinding processes. The use of water on solid emery wheels is a survival of the old Sheffield methods, in which huge grindstones are run in a stream of water, in which the workman straddles a board that presses his work against the stone, in which the heaviest man is the best grinder.

The use of water has been urged indiscriminately as an excuse for an increased variety of grinding machines, and, in times past, as a method of using emery wheels too weak and poor to be used dry. It is not an uncommon thing to read, in commercial literature, that certain wheels can be used equally well wet or dry. In justice to the getters-up of such vague assertions, it is assumed here that they are not intended to imply equal products by the wet and dry processes. It is to be feared, however, that the long-continued and oft-repeated assertion of this generality has created a false impression.

In opposition to any such view, it should be stated in the strongest way that water is a lubricant. Exact data on this subject seem to be almost entirely lacking, but the only ones known to the writer (and procured under his supervision) are now given. Seven different makes were tried under conditions identical except as to the fact that in one series the wheels were used dry and in the other series wet. Sixteen consecutive, intermittent cuts were made by each wheel in each series of trials, the speed being about one mile per minute, the pressure about 112 pounds per square inch, and the material ground cast iron. The total product of five of these wheels under the dry process was 186 12-16 ounces, while under the wet it fell off to 24 13-16 ounces. Two (out of the seven) wheels gave a larger product under the wet process than under the dry, but this result confirms the facts previously adduced as to over-hard wheels and the lessened product due to metallic adhesion. In 32 minutes these two wheels ground off, under the dry process, 2 2-16 ounces, and, under the wet process, 10 2-16 ounces. It seems evident that in this case the use of water lessened the metallic adhesion.

The fact is that water is only necessary to protect metal from the effects of heat. Where there is danger of warping in some article held while cold under the stress of undue tension, or where some desired temper is altered, water can be advantageously employed, but its indiscriminate use (on tools, for instance) encourages careless methods. The dry process carries on a steady educational work, the grinder acquiring increased delicacy of touch and greater knowledge as to the contraction, expansion, density, stress, and temper of metals.

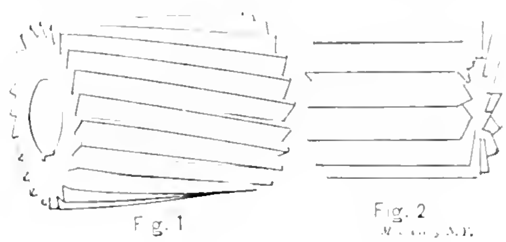
It is a too common assumption that tools cannot be properly sharpened on a dry wheel, yet experienced operators can produce any desired temper by the skilful use of the dry process. The tempering furnace has been (in at least one instance) abandoned for a tempering wheel, and saws have been given an increased durability by the special hardness due to careful use of a dry wheel.

The advantages of intermittent pressure, as affecting the heat problem, are very evident, and the disadvantages of grinding with a flat surface have been pointed out. The facts that high-speed is connected with a free cut, and that a free cut generates the least heat, are well understood. It will, therefore, be readily perceived that if a knife edge is ground on the flat surface of a wheel at half speed, under an unyielding screw feed, all the elements of temper destruction are present. Nevertheless, a 2-foot planer-knife, with bevel 13-16-inch wide, has been successfully ground on an automatic knife-grinding machine with a dry wheel, under the disadvantageous conditions just stated. The record states that such grinding did not blue the knife, which remained cool enough to handle. If a machine can do this, what will not the sensitive and delicate hand of a skilled workman accomplish?

THE SHAPING, GRINDING AND HARDENING OF MILLING CUTTERS.

Zeitschrift fur Werkzeugmaschinen und Werkzeuge, May 5, 1904, p. 316.

The milling cutter plays a most important part in the modern workshop and a great deal of attention has been devoted during the past twenty years to its development. In the care of these tools the methods have grown from the use of the file for dressing and shaping to the almost universal employment of the emery wheel for that purpose. These cutters may be divided, according to the work that they are intended to perform, into two main groups; the axial cutter, as shown in Fig.



Axial and Radial Cutters

1, and the radial miller of Fig. 2. The first works on a plane parallel to its axis, and the latter on one at right angles to the same. The form of the teeth in the two also differs. For example, we make the cutting angle, B, of Fig. 3, and the clearance angle, c, the same as that of a flat chisel for use on the same metal, while the angle of rake for cast iron runs from 0 to 2 degrees, and that for wrought iron about 5 degrees. The clearance angle had best be the same for all cutters, and for both metals from 5 to 8 degrees. In the matter of the form of the clearance surface, R, there should be a difference between the two kinds of cutters. Ordinarily a tooth of triangular section is used; though, for form cutters, the trapezoidal as in Fig. 3, is also found. It is well known that the face of the tooth s is the place where the grinding is done in the case of the tooth that is to be maintained in constant shape, and the angle of rake must then be kept equal to 0 degrees. The teeth of ordinary cutters on the other hand are sharpened on the back. It is, therefore, easily seen that, in the first method of sharpening it is necessary to remove much more metal than in the latter

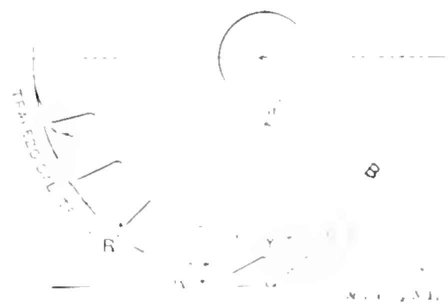


Fig. 3 Illustrating the Shapes and Angles of Teeth

with the result that much more is wasted. This is shown graphically by the hatched portions at the cutting edges of the ordinary and trapezoidal teeth shown in Figs. 4 and 5.

In the cutter with teeth of the ordinary form, the angle of rake a is fixed. It is, however, by no means a matter of indifference as to the form of cutter that shall be used in shaping the teeth. Figs. 6, 7 and 8 show the three forms of cutters that may be used in shaping the teeth on a cylindrical surface. In the forms shown in Figs. 6 and 7 one of the cutting surfaces lies at right angles to the axis of the cutter. In this it is of importance that the end cutting section a should work upon the face of the tooth as in Fig. 6. On the other hand, it is a great disadvantage that the points of the teeth should be so exposed that they cut a more or less jagged surface on the face of the cutter. A better arrangement is that shown in Fig. 7, where the cutters for the front of the tooth run parallel to the

same. A better piece of work can be done with a cutter shaped like that shown in Fig. 8, where both surfaces are worked out by cutters running parallel to them. The adjustmeut of such a cutter can best be made by means of a sheet metal templet like that shown in Fig. 9. It should be provided with a hub, *N*, whose hole will fit over a mandrel or stud run through the center of the cutter to be milled. The angle *a* for cutters intended for use on cast iron had best be made of from 3 to 6 degrees, according to the rake that is desired. The number of teeth, their pitch and depth are, for the most part, left optional, with the result that even in large and well-built machines there is a great deal of chattering.

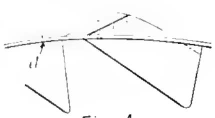


Fig. 4

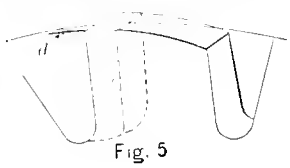


Fig. 5

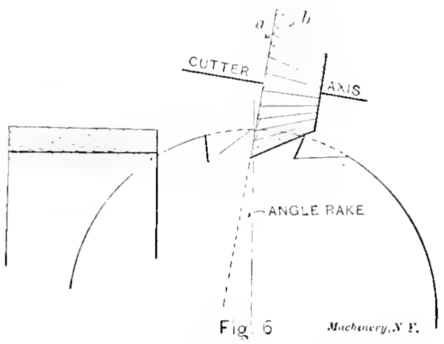


Fig. 6

Relative amount of Metal Removed in Sharpening—One Form of Cutter used for Shaping Teeth.

No hard and fast rule can be laid down for this work, and existing practice is quite varied in its details. In his own practice the writer has taken quite a simple course: The diameter, *D*, of the cutter is first obtained; this depends upon the work to be done and should be as small as possible. The thickness of teeth, *t*, should then be determined from the following formula that has been derived from practical experience:

$$t = \frac{D}{10} + c$$

For cutters up to			2	inches diameter	$c = \frac{3}{16}$ inch.
" "	from 2	inches to	4	" "	$c = \frac{5}{32}$ "
" "	" 4	" "	$4\frac{3}{4}$	" "	$c = \frac{1}{8}$ "
" "	" $4\frac{3}{4}$	" "	6	" "	$c = \frac{1}{16}$ "
" "	" 6	" "	$7\frac{1}{4}$	" "	$c = \frac{1}{32}$ "
" "	" $7\frac{1}{4}$	" "	8	" "	$c = 0$ "

In order to determine the number of teeth, the nearest whole number to the quotient of $\frac{3.1416\ D}{t}$ should be taken. Thus for a cutter of 4 inches diameter we would have 24 teeth and this would cause a modification of the calculated thickness of the tooth from .55625 inch to .5027 inch.

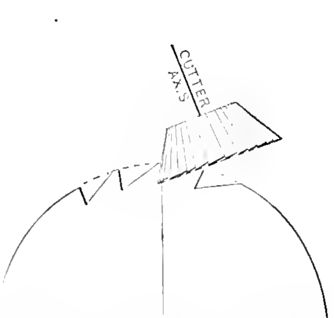


Fig. 7.

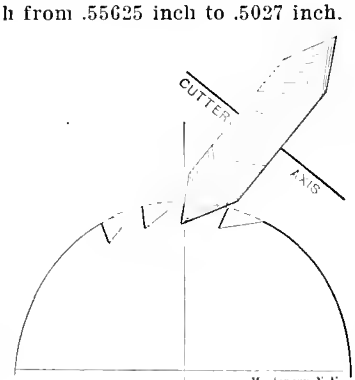


Fig. 8

The exact clearance angle, *c*, Fig. 3, should be given to the tooth by grinding. The grinding of the ordinary milling cutter is done in three ways, each of which has its advocates. In the first and oldest methods it is done at the back on the face of the clearance angle, as shown in Fig. 10, with a small emery wheel, which should, however, have as large a diameter as possible, so that the surface may not be ground hollow. This concavity of surface is the principal objection to this method of grinding, but on the other hand the defect can be readily obviated if the axis of the emery wheel in the horizontal plane is made to stand at a slight angle with the axis of the cutter, as in Fig. 10, instead of parallel to the same, and especially if the cutting face is turned in a direction opposite to that of the inclination of the cutting edge. A special difficulty is to be found in this as well as the other methods of grinding in so adjusting the wheel that the proper clearance angle, *c*, will be given to the tooth. In fact one is dependent entirely upon an inspection or test and the experience of the workman. If the teeth are of the ordinary form, and do not vary essentially from that called for in the rule given above, the clearance angle can best be tested by means of a straightedge laid over two teeth, as shown in Fig. 11, in which the clearance surface of tooth *l* should coincide with the face of the straightedge. If the teeth are pitched closer together than the rule calls for, the angle should be sharper than that of the straightedge. It is also important that the guide, *s*, Fig. 10, by which the tooth being ground is held in place and which governs the position of the tooth relatively to the emery wheel, should be brought to bear against each and every tooth and not against every second tooth, as is the case in common practice. For the sake of convenience this precaution is frequently neglected, with the result that the grinding is not the same on all of the teeth.

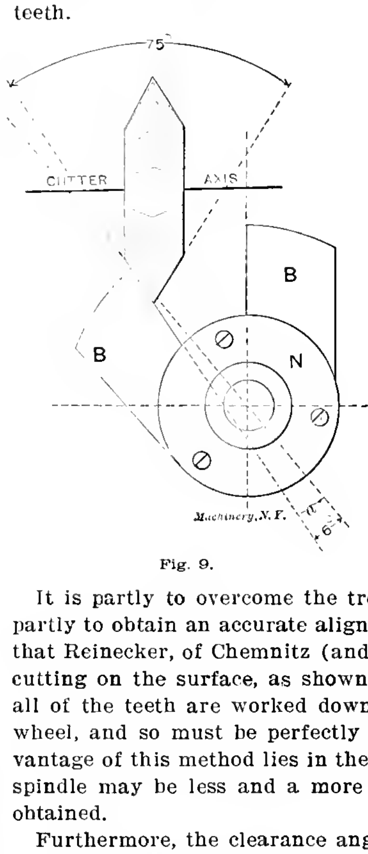


Fig. 9.

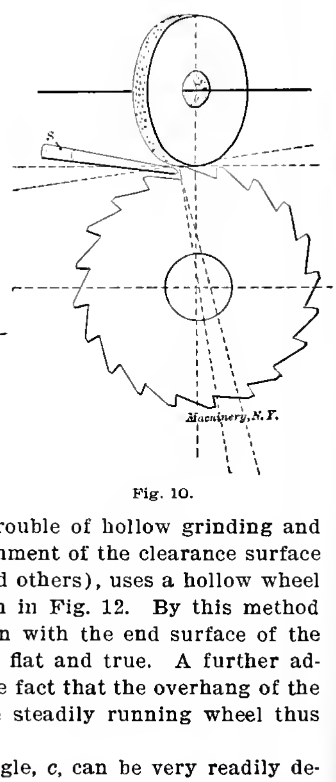


Fig. 10.

It is partly to overcome the trouble of hollow grinding and partly to obtain an accurate alignment of the clearance surface that Reinecker, of Chemnitz (and others), uses a hollow wheel cutting on the surface, as shown in Fig. 12. By this method all of the teeth are worked down with the end surface of the wheel, and so must be perfectly flat and true. A further advantage of this method lies in the fact that the overhang of the spindle may be less and a more steadily running wheel thus obtained.

Furthermore, the clearance angle, *c*, can be very readily determined by an examination so that it may be regulated by a fine adjustment of the guide, *s*, against the tooth that is being ground. The greater surface of wheel in contact with the tooth, however, increases the danger of heating, and for that reason the use of the hollow wheel is sometimes specifically forbidden.

The third method consists in the grinding of the tooth on the front and back at the same time. It is done in exactly the same way as the work of cutting the tooth in the first place, except that, instead of the milling cutters used, as in Figs. 7 and 8, an emery wheel is used, as in Fig. 13. Special automatic machines are built for this purpose and the advantages claimed are that the height of the tooth is not decreased, because of the fact that the wheel is at work on two surfaces so that the cutter does not have to be reheated and rehardened after a short period of wear. This advantage disappears, however, because it has been ascertained that the deepening of the tooth

by grinding requires the removal of so much metal that a great deal of time is required, if, indeed, the whole center is not thrown out of shape by the heating that results from such a grinding. So that the consensus of opinion is that one of the first two methods of grinding on the clearance edge is that to be preferred.

It is of the utmost importance that this grinding should be done on a well-built and reliable machine, for no machine having to do with milling can so easily get out of adjustment and do bad work as an emery grinder; and then, when bad

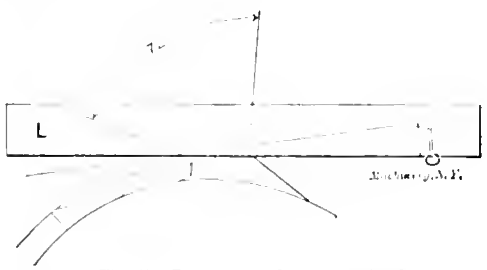
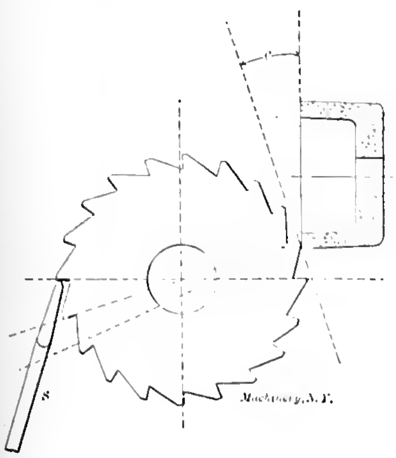


Fig. 11. Testing the Clearance Angle.

work has been done, it is usually first detected when a job has been spoiled in shaping. Good emery grinders and skillful operators of the same are, therefore, quite as important as the milling machines and cutters themselves. It is, then, not only necessary that the cutting and clearance surfaces should be ground to the proper angles but that the grinding should be so carefully done that the edges of the teeth shall not be heated. If, during the grinding with an emery wheel, the teeth of the cutter are heated to such an extent that they turn blue, the grinder can easily obliterate all traces of his carelessness, by simply passing the wheel once gently over the surface, and then it will not be detected until some defective piece of work is turned out, when the workman and foreman will be more apt to attribute it to the faulty hardening of the cutter than to the man who ground it. For these reasons it is not well to grind the face of the tooth, because overheating is at once visible and the workman has a chance to cover the mistake. The simplest means of avoiding heating in grinding is to use a wet wheel—a method that is most feasible with the Gould & Eberhardt machine where a strong stream of water may be directed against the work, and not one drop be thrown out. It has also been frequently observed that of all things connected with the careless handling of the grinding machine, the overheating of the stock is the most common. An efficient wet-



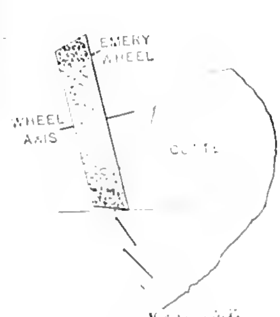


Fig. 12. Fig. 13

grinding machine for working on all sorts of ordinary milling cutters, does not seem to have been brought out as yet and therefore the field is open to some skillful designer to fill the gap.

By careful watchfulness over the grinding machine, faulty grinding can frequently be avoided. If, for example (it may be remarked in passing), a strong stream of sparks is produced in the sharpening of a cutter, it is safe to conclude that too much metal is being removed at a time, and that the cutter will be heated and left out of round. Again, if, when at a short distance from it, the emery wheel is heard to work with a series of dull blows, it will be found that it is not cutting, but is merely sliding over the teeth of the cutter and heating them. A noisy emery wheel is either dirty or glazed over and must be turned down, else it is hard and fine grained. A properly working emery wheel produces a steady ringing tone, which is recognized at once as evidence that it is cutting. In short, wide-open eyes and sharp ears are the most efficient assistants to the careful grinder.

For a long time, now, milling cutters of large diameter have not been made of a single piece, but with a number of inserted teeth. The fastening of these teeth in the cutter head is accomplished by means of screws, keys or by casting them in. Experience with certain forms of these inserted teeth has been that with the ordinary forms of axial and radial cutters, the pitch must be made greater, and the teeth stronger. Hence the shape shown in Fig. 14 has been developed, which differs slightly from that shown in Fig. 3, in that the clearance surfaces are made broader and the curve at the root of the tooth sharper. The difference from the form of Fig. 3 is really very slight; for, in place of the curved clearance surface, *R*, it is straight. Teeth of this form are made in the same way as those of Fig. 3, with the exception of the clearance surface, which is first cut with a miller and then, after hardening, is ground with a hollow wheel, as shown in the second method, Fig. 12. Milling

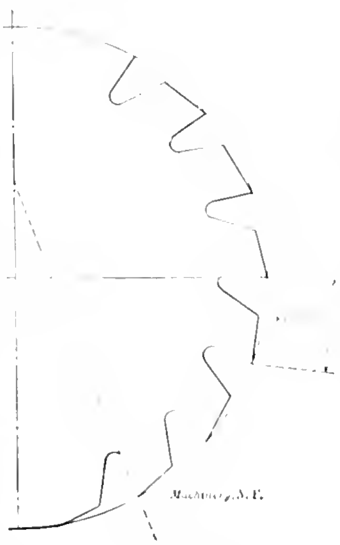


Fig. 14 Fig. 15.

cutters of this kind when run upon strong, well-built machines are capable of taking a very heavy cut with a comparatively small expenditure of power.

A few words should also be said regarding the screw shape or longitudinal pitch of the teeth. The twist of the teeth is a necessity, to insure that the whole of the work shall not, at any instant, be thrown entirely upon one tooth, and that the cut shall be a drawing one so as to clear itself well. A diamond-shaped cutting edge is a necessity. In ordinary cylindrical milling cutters the cutting edge of the tooth usually stands at an angle of from 15 to 20 degrees with the center line; and it is, furthermore, immaterial whether it leads to the right or the left. In vertical- and side-cutting millers, such as bar cutters used for profiling, that twist, on the other hand, should be from left to right when looked at from above, if the cutter is to be used in a hole; since a left-handed twist would tend to carry the chip downward, and also force the piece being operated upon down against the table or platen. Bar cutters, which also work at the ends, as well as the regular end mills, must have teeth leading to the right, and it is especially necessary that the rake or cutting angle of these end cutters should be quite blunt. For bar cutters working on the sides only, the inclination of the cutting edge to the axis of the cutter may be made larger, and rise to from 30 to 40 degrees; which, especially on wrought iron, gives a marked advantage in cutting. In the case of end cutters this angle should not be more than 20 degrees, else the teeth at the end will be made too sharp, as in Fig. 15, and thus be too easily broken; whence the twist angle of the cutting edge which becomes the rake angle of the end teeth should be limited to 20 degrees at the highest, instead of the 30 degrees previously recommended.

It remains, now, to say a few words regarding the hardening of milling cutters, a subject which has already been frequently

discussed. For the machinist in small shops, where a special hardening plant is not provided and where the milling cutters must be hardened in the shop smithy, a few practical suggestions will not be out of place. It is, of course, self-evident to the veriest tyro of a machinist that only the very best of steel should be used for milling cutters. This necessitates a very careful manipulation in itself, aside from the dangers to which the steel is subjected by the many forms into which it may be put. In order to avoid internal stresses of the metal, milling cutters ought, under all circumstances, after being formed and before hardening, to be heated once to a red heat. This heating can be done in an oven, or, in the absence of this, in a plate metal box or piece of pipe in which it is packed in charcoal. The whole may then be raised to the hardening temperature of from 1,600 to 1,900 degrees F. in an open fire and afterward left to cool either in the oven or box. The heating for hardening can also be done in a closed box when no lead bath or muffle-furnace is available. In order to prevent the slightest particle of oxidation it will be well to coat the cutter, before heating with a layer about 1-16 inch thick of heavy soft soap. The temperature of the hardening water should under no circumstances be less than 70 degrees F. A mixture of 3 pounds of soft soap and 1 quart of muriatic acid in 25 gallons of hard water, will materially assist in the hardening, especially by delaying the cooling of the sharp edges of the teeth somewhat and thus lessening the internal tension, without acting in any way prejudicially to the hardening.

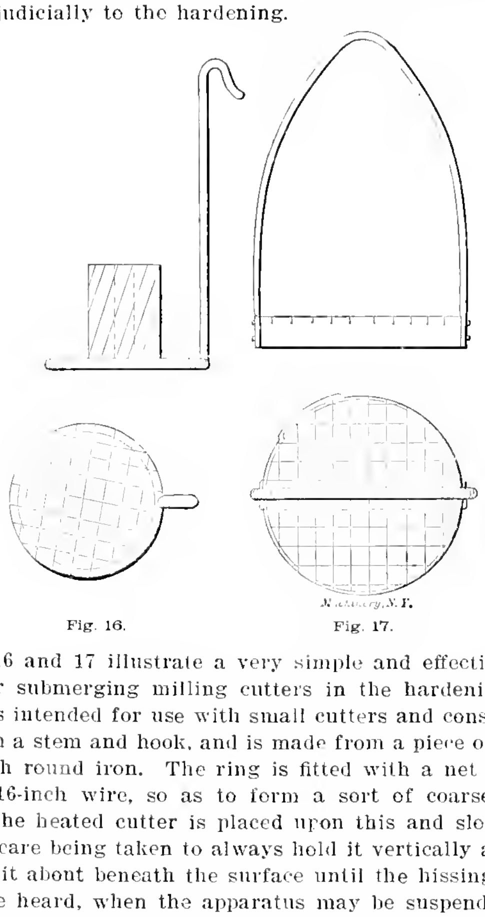


Fig. 16. Fig. 17.

Figs. 16 and 17 illustrate a very simple and effective apparatus for submerging milling cutters in the hardening bath. Fig. 16 is intended for use with small cutters and consists of a ring with a stem and hook, and is made from a piece of ½-inch or ⅝-inch round iron. The ring is fitted with a net made of about 1-16-inch wire, so as to form a sort of coarse-meshed sieve. The heated cutter is placed upon this and slowly submerged, care being taken to always hold it vertically and then to move it about beneath the surface until the hissing can no longer be heard, when the apparatus may be suspended from its hook and left until the piece is thoroughly cooled. The wire mesh gives the water access to the bore in the piece as well as to all portions of the teeth. End millers should be placed upon the netting with the teeth uppermost, so that the thin portions may be cooled last and be fixed. Otherwise there will be danger of cracking. Fig. 17 is a similar arrangement for large and heavy cutters, which a man could not readily handle alone. The ring may be made of band iron from ⅛ inch to 3-16 inch thick and about 2 inches wide, with holes for the fastenings of the wires. The handle made of round iron is fastened to the ring with two rivets on each side. For submerging heavy cutters a bar may be passed through the handle and the whole manipulated by a man at each end. While the hardening is being done, the room should be free from drafts, and glaring daylight or bright sunshine should be deadened by painting the windows or covering them with curtains.

A milling cutter, in unskillful hands, can be ruined in a few minutes by a workman who does not understand that everything depends upon deliberation and care. Proper manipulation on the machine is therefore as essential as the proper shape and preparation. A whole chapter could well be written regarding the use of cutters in the milling machine, but the limitations of space forbid and we will confine ourselves to a few words. The speed of cutting, the feed and the depth of the cut must be governed by the material, the character of the cutter, and especially the character of the work and the shape of the piece. The speed of the cutter is alone dependent on the type of cutter, the feed and the depth of the cut. It is customary in cases of doubt to run the cutter at a certain given speed and then crowd the feed until the limits of heating are reached, or up to the strength of the machine and the resistance of the material.

The following speeds, however, will be found to be very satisfactory:

For cast iron: roughing, 35 feet per minute; finishing, 45 feet. For wrought iron with water cooling: roughing, 40 feet; finishing, 65 feet. For cast steel with water cooling: roughing, 45 feet; finishing, 60 feet. For bronze bearings: roughing, 75 feet; finishing, 100 feet.

With star-shaped cutters whose sharp edges are easily broken, somewhat lower speeds than these must be used, and the rate of feed per revolution must be reduced also. G. L. F.

THE TRANSITION PERIOD IN MACHINERY.

Extract from Address by Mr John R. Freeman at the Case School of Applied Science, May 11, 1904.

This is a transition period, and never was there such opportunity for the trained engineer. Mechanical production must supply the natural increase due to the growth in population, and replace machines worn out by service, and even new machines by something newer. Here in Cleveland your horse cars were not worn out when the cable car replaced them, your cable railways were not worn out when the electric car came in. Not only the equipment, but the shop that makes it, must largely go into scrap. Two or three years ago one of the leading engine builders of the world began on new shops in a city on the Great Lakes, the largest of their kind, designed for building engines of the most massive type. Hundreds of thousands of dollars were expended on these shops and their heavy machine tools, but before these shops were occupied, customers were inquiring, not for engines but for steam turbines. The leading pump builder of America began two years ago on new shops near New York, these also to be the largest in the world; the plans had been matured by years of study for building pumping engines of the ordinary reciprocating type. Before these shops are ready for occupancy the old and simple and inefficient type of centrifugal pump is suddenly so improved as to threaten a revolution which may profoundly change the type of shop equipment demanded. A maker of valves and fittings, a concern which has kept steadily up-to-date for more than a quarter of a century, started, about two years ago, to supply its expanding trade by a factory on the shores of Long Island Sound, designed to employ at first 2,000 and later 4,000 men. The plans were matured with rare care and judgment. First, their man of greatest skill in shop methods plans for his various machines and lays out his floor space. Next, the skilled mill engineer makes plans to house that floor space in. Next, an architect, of national reputation for his inborn sense of beautiful form and graceful line, models the outlines of exterior wall and windows and roof. Machine tools of latest design had been purchased, apparently everything had been provided for, when, just as the roofs are on, the successful demonstration of a new kind of tool steel, which permits of far deeper and more rapid cuts, calls a halt and requires a radical change.

* * *

The 15,000-ton battleship, *New Jersey*, was launched from the Fore River shipyard at Quincy, Mass., November 10. The *New Jersey* is one of five similar vessels which were authorized by act of Congress in 1899 and 1900, and has one feature of design in common with the *Kearsarge* and *Kentucky*, four of her 8-inch guns being in superimposed turrets. She will be propelled by two four-cylinder triple-expansion engines of 19,000 indicated horse power at a speed of nineteen knots.

ON THE SHAPE OF ROLLS FOR CYLINDER CAMS.

R. E. FLANDERS.

The grooves and rolls for cylindrical cams are made in various ways, more or less suitable for the work to be done. The writer had occasion, a short time ago, to give a little thought to this matter, with the following results:

Fig. 1 shows a straight roll and groove, Fig. 2 a roll with a rounded surface in a straight sided groove, and Fig. 3 a beveled roll and groove. In Fig. 1 the action of the roll is faulty, because of the varying surface speed of the cam at the top and bottom of the groove, due to its varying radial distance from the center line. This causes excessive wear and friction, especially in a quick running cam with steep pitches. For such cases, if the duty is light, the arrangement shown in Fig. 2 is better, as the roll has but a very small bearing sur-

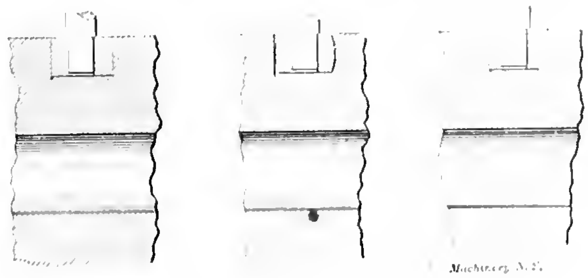


Fig. 1. Fig. 2. Fig. 3.

face, and is thus unaffected by a varying radial distance. For heavy work, however, the small bearing area is quickly worn down, and the roll presses a groove into the side of the cam as well, destroying the accuracy of the movement, and allowing a great amount of backlash.

In Fig. 3 the conical shape is given to the roll with the idea of giving it a true rolling action in the groove. In most cases which the writer has noticed, the lines of the sides of the roll appear to converge on the center line of the cam, as shown in the figure. If the groove were a plain circumferential one, it would give a perfect action, like that of the pitch cones of two bevel gears rolling on each other. If the motion were in a line with the axis of the cam, without any circular movement, conditions would be perfect in Fig. 1. It is evident that in intermediate conditions, the groove must be given a shape intermediate between the two. In many cams of this variety the heavy duty comes on a section of the cam which is of nearly even pitch and of considerable length. In such a case it is best to proportion the shape of the roll to work correctly during the important part of the cycle, letting it go as it will at other times.

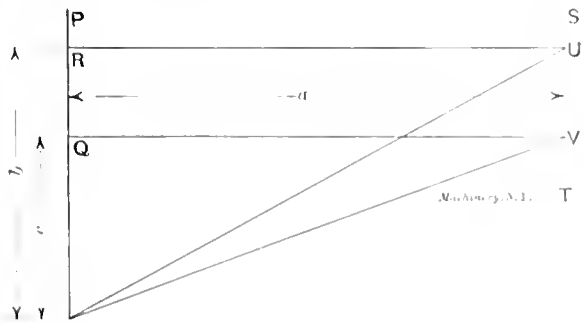


Fig. 4. Diagram showing Method of Finding the Shape of Cam Rolls.

In Fig. 4, b is the circumferential distance on the surface of the cam, which includes the movement we desire to fit the roll to. The throw of the cam for this circumferential movement is a. Line OU will then be a development of the movement of the cam roll during the given part of the cycle, and c is the movement corresponding to b, but on a circle whose diameter is that of the cam at the bottom of the groove. With the same throw a as before, the line OV will be a development of the cam at the bottom of the groove. OU then is the length of the helix traveled by the top of the roll, while OV is the amount of travel at the bottom of the groove. If then the top width and the bottom width of the groove be made proportional to OU and OV, the shape will be suitable to give the result we are seeking.

RALPH E. FLANDERS was born at Barnet, Vermont, September 28, 1880. His education includes four years in high school, and he served his apprenticeship in the works of Brown & Sharpe Mfg. Co., Providence, R. I. He has since worked for the Taft-Peirce Mfg. Co., Flather & Co., and the International Paper Box Machine Co. Mr. Flanders has worked as apprentice, journeyman, draftsman and designer of tools and methods of manufacture. His specialty is the design of automatic machinery for light and medium weight manufacture.

* * *

A SYSTEM OF DRILL JIGS FOR ROUGH CASTINGS.

H J BACHMANN

H J Bachmann

The recent contributions to MACHINERY in reference to drill jigs are interesting, but there is one type of jig that has not been described. It is an old idea in a new form and it has proven itself immensely profitable wherever employed.

Herewith are given a few sketches and a description of two jigs for drilling castings that have not been previously machined, *i. e.*, are just as they come from the foundry. It is not very difficult to design a jig when there is some part of the casting finished to size, but when there is practically nothing to start from, it becomes quite a serious matter. If we are to judge from the number of discarded jigs in the shops it seems that quite a few toolmakers have "fallen down" on this problem.

The principal feature of these jigs is, of course, the screw bushings, two of which are shown enlarged in Figs. 3 and 4. By screwing down on the bushing the casting is clamped between the screw bushing and the plain bushing shown in the bottom of the jigs. Thus it will be seen that they perform the double function of locating the hole and also holding the casting securely in its proper position in the jig. When only one end of the boss is accessible the plain bushing cannot be used, and other means must be devised to back up the thrust of the screw bushing.

Being movable they will take care of any reasonable variation in the size of the castings and also insure that the hole shall be drilled in the center of the boss. This latter condition is very desirable in work of this kind, for the sake of appearance and strength. In this form they are rendered applicable to all forms of castings having any kind of a circular projection or boss over which the bushings may be fitted, as shown in the cuts.

When headless bushings are necessary (as on both ends of the larger jig, Figs. 5, 6 and 7) they are tightened down with a spanner, whereas a plain drill rod pin is sufficient for the other. When both ends of the boss are held by bushings the holes to receive these bushings must be in line and when they are so aligned it is impossible for the hole to come out of center on either end of the boss. The simplest and safest way to align these holes is to run a single-pointed boring bar through the screw bushing into the bottom of the jig after the screw bushing has been fitted to the jig, the shank of the boring bar, of course, to be a good fit in the hole of the screw bushing which has been previously lapped to size.

On the larger sizes of bushings it has been found advantageous to use a good quality of machine steel, case-hardened and having a smaller tool steel bushing inserted in the center. When made of all tool steel the distortion caused by hardening is too great to allow a good fit, which is essential on the threaded portion.

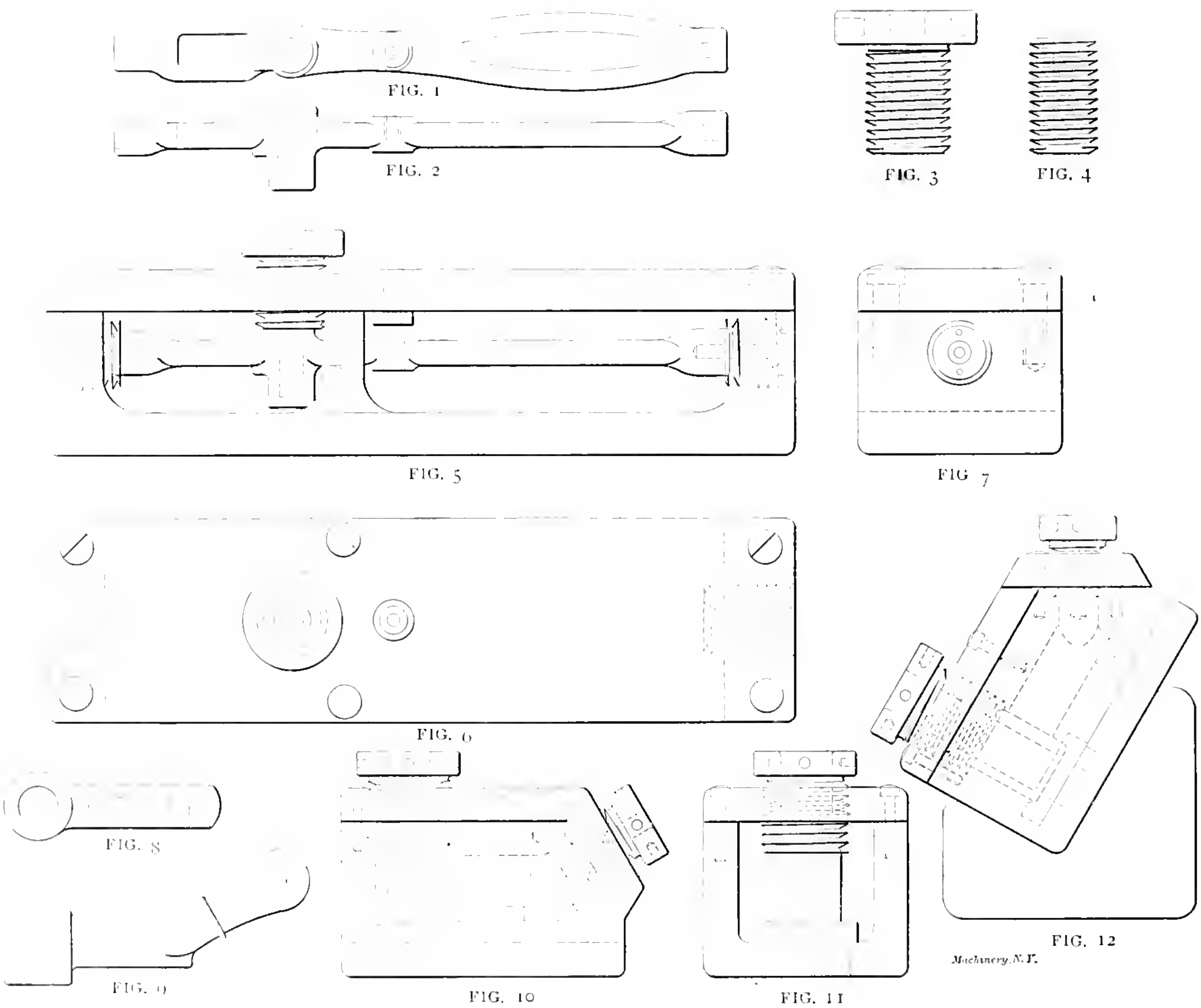
The bodies of the jigs are made of cast iron, cradle shaped and cut out where possible to facilitate cleaning. The covers which hold the screw bushings are of machine steel, held in place by means of fillister head screws and dowels.

HENRY J. BACHMANN was born in Birsthal Baden, Germany, March 28, 1880. He took a course in Pratt's Institute, Brooklyn and served an apprenticeship with the Brass Goods Mfg. Co. of that city. He has since worked for the Neptune Meter Co., General Incandescent Arc Light Co., F. A. Errington and the Cutler-Hammer Mfg. Co. He is a toolmaker and his specialty is tools for brass working. Mr. Bachmann has been an occasional contributor to MACHINERY for a number of years.

The larger jig, Figs. 5, 6 and 7, was designed for drilling the breast drill frame shown in Figs. 1 and 2. The casting is clamped by the large bushing first and then the smaller bushings on the end are brought up just tight enough to obviate any spring in the casting. There are two holes in this frame which must be reamed square with each other. After trying unsuccessfully to ream the holes by hand after drilling in the jig the holes were reamed in the jig as follows: The hole in the bushing was made the exact size of the hole to be reamed in the casting. A drill of this size was used to spot the hole, following with a reamer drill and lastly the rose reamer, making in every respect a satisfactory job.

The smaller jig, Figs. 10, 11 and 12, designed for the simple lever shown in Figs. 8 and 9, presents no difficulties beyond the drilling and tapping of the hole for the wooden handle at an angle of 30 degrees, and the adjustable stud screwed into the bottom of the jig to resist the pressure of the bushing. In this jig it is also necessary to clamp the larger boss first, so that when the smaller bushing is tightened there will be no tendency to displace the casting. The same procedure was followed in the case of the tapped hole as in the case of the reamed hole, namely: full size drill to spot, tap drill and then the tap itself. This latter was operated by means of a tapping attachment with friction chuck. The advantage over tapping by hand was evident because every handle fitted the lever just as shown in the sketch, adding greatly to the appearance of the finished article. The method of tilting the jig by means of the 60-degree angle block, Fig. 12, is open to criticism, but inasmuch as it was the simplest way, it was adopted. It is hardly necessary to say that these jigs are most profitably employed in connection with a multiple-spindle drill press, but even with a single spindle press they will show a saving over some ancient devices.

There is one thing that is generally overlooked in the construction of jigs and that reminds the writer of a very conspicuous sign in a large patternmaking shop—"Round all edges and fillet all corners"—should apply to the toolmaker as well as the patternmaker, for if he does not take the trouble to finish his work the boys in the shop will finish it for him in a way he won't like.



System of Drill Jigs for Rough Castings.

* * *

NOTES ON TOOLMAKING.

FRANK E. SHAILOR.

A good rule to follow when planing work is: "Plane the widest surface first." For instance, a die block is to be planed all over. The wide side is done first, next one edge, the block being positioned by the wide side just planed, bearing against the solid jaw of vise; then the block is inverted and the other edge planed, it being still positioned by the planed wide side against the solid jaw. We now have three planed surfaces to position the block for the last wide side. If the edges are planed first, as is customary with a great many machinists, it is obvious that the edges were positioned by unplaned, and therefore untrue, surfaces, hence they will not be parallel with each other. Moreover, the edges do not furnish ample bearing to properly position the block for planing the wide side at right angles.

When planing any work where absolute parallelism is required, never depend on the vise or bed of the machine unless the bed has been very recently trued up. A very good way to accurately machine work and to overcome the necessity of truing the bed, is to machine the piece all over to within a few hundredths of size, and then grip a piece of scrap steel or cast iron in the vise, or on the bed of the planer (or surface grinder) and carefully machine the surface. We now have a surface true with the crosshead of the planer or emery wheel spindle of the grinder. The piece to be finished is in

turn waxed to said true surface and with a keen cutting tool or emery wheel the piece can be accurately brought to size.

A wax suitable for this purpose is composed of 7 parts beeswax, 2 parts rosin, and 1 part shoemaker's wax melted together and thoroughly mixed. Just before the wax is cold, form into conveniently shaped sticks. The wax is applied around the edges of the work with a warm soldering iron, but care must be taken that no grit or wax gets under the piece to be machined. The wax does not become brittle so it can easily be removed with a copper scraper and used over and over. It is

Fig. 1 Diamond lap

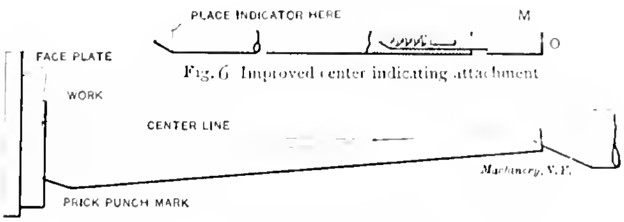


Fig. 6 Improved center indicating attachment

Fig. 7 Showing how location of prick punch mark is changed, when using solid bar

Notes on Toolmaking.

understood, of course, that "cut-meter" speeds cannot be employed when using wax for holding work. Light chips must be taken, especially on the surface grinder, as heavy chips would warm the work and cause the wax to melt. The holding qualities of this wax are such that the bed of a No. 2, B. & S. surface grinder can be moved back and forth by means of a piece of steel 3 inches square waxed to the bed. For holding thin work that must be straight when finished, the

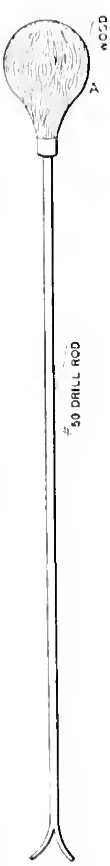


Fig. 2.

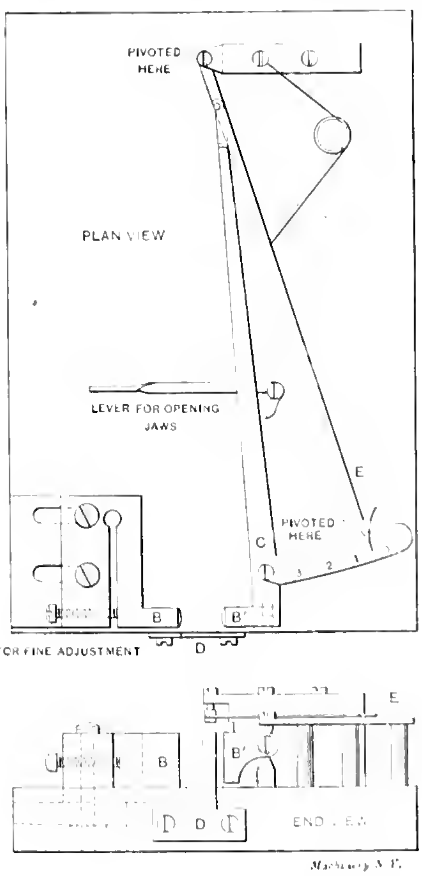


Fig. 3

wax will be found superior to the magnetic chuck, for the chuck exerts such a tremendous pull that if a piece of work is slightly sprung it will straighten against the magnetic face and after the piece has been ground and removed from the chuck, it will be found to have assumed its original curved form.

Grinding with Diamond Dust.

Diamond dust of all grades is an indispensable article in the up-to-date toolroom. To cite the many uses to which diamond dust can be profitably applied would require considerable space, and so only a few will be mentioned. It is extremely valuable in grinding small spring chucks having holes, say 0.060 inch in diameter. It is impossible to use an emery wheel in a hole of such diameter and unless the hole is ground the chuck will not, as a rule, run true. By charging the lap, Fig. 1, uniformly with diamond dust, a very small hole can be ground as nicely as though it were a 2-inch hole ground by an emery wheel. The lap is charged with diamond dust by rolling it between two hardened surfaces, but the dust should never be *pounded* into the lap. To obtain the best results the lap must run true and cut all around, but this is not possible if the dust is pounded in the lap, for the hammer blows produce minute flat spots, so that only the corners or high spots touch the work. Diamond dust does not spark and it is an easy matter to crowd the lap and strip some of the dust. To overcome this possibility the "harker" shown in Fig. 2 is brought into play. The forked end is placed against

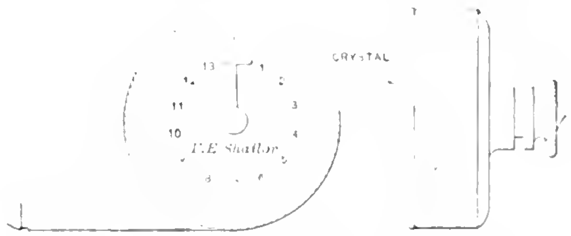


Fig. 4 Indicator for general work, assembled. Multiplies [illegible] times.

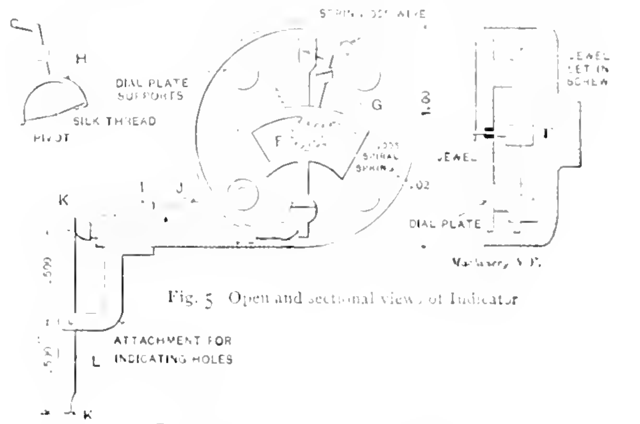


Fig. 5 Open and sectional views of Indicator

Sensitive Indicator for General Work

some stationary part of the grinder spindle, and end, A, placed in the ear. The movement when the lap touches the work is readily noted as the slightest sound magnified many times vibrates along the rod. The harker is nothing new, for our fathers were content to use an ordinary file in place of the more elaborate tool shown at Fig. 2.

One thing that must be closely watched when using diamond dust for grinding is that the lap does not become dry, but is kept moistened with a thin lubricant. Kerosene is excellent for this purpose. Soft work should never be ground with diamond dust as the dust will leave the lap and charge the work. The writer has often made small gages, both plug and ring, by roughly grinding first with No. 1 diamond, and then substituting for the lap one containing No. 5 or No. 6 diamond (which is very fine), lapping the gage to size at the same setting.

In grinding a plug gage much difficulty is experienced when calipering to find if the gage is perfectly straight. No matter how skillful a mechanic may be in using the micrometer, he is sure to apply uneven tension on work when measuring, and as 0.0001 inch one way or the other ruins a plug gage for accuracy, the simple little tool shown in Fig. 3 will be found of exceptional value in determining the straightness of a gage, though not the size unless it is set with a standard. The gage here shown multiplies errors 200 times. The jaws, *B*, *B'*, are hardened, ground and lapped. Jaw *B* is adjustable, while the other jaw is movable and connected to indicator point, *C*. An adjustable stop, *D*, is provided for the work to rest on, so that the jaws will be squarely in contact with the work. If three gages are to be made, as is customary, the indicating instrument will be found valuable in making them exactly the same size. When one is finished satisfactorily,

set the gage between the jaws of the indicator and note the graduation recorded by pointer, E. Since the indicator reading is 200 times greater than the actual error, it will now be easy to make the other two gages as nearly alike as it is possible to get them. It has often occurred to me that this style of instrument would make an excellent universal gage for pieces of work ordinarily measured with a snap gage, having a limit of 0.0001 inch or 0.0002 inch. All that would be necessary to make one indicator cover a large field of work, would be to retain a standard of each piece to be gaged, and set one indicator to said standard. An indicator of this denecessary to make one indicator cover a large field of work, each year for the reason that 0.0001 and often 0.00001 inch prevents a piece entering the ordinary snap or ring gage and it is thrown out. On the other hand a piece enters the gage and is accepted, but said piece is often as much below size as the piece thrown away was above. With the inspector it is a matter of go in or not go in. If it goes in it is "all right," if it does not go in, it is "scrap."

Fig. 4 shows another style of indicator that I designed and built for my own use. The dimensions are given here for the benefit of those who are occasionally inclined to do "Government work." This indicator is very sensitive and can be used on locomotive building, thus covering the entire field. The objection to most indicators now on the market is that they are not sensitive enough for small work, such as watch or instrument pivots, and will cause said pivot to "spring" before sufficient pressure is applied to make the indicator needle register. The indicator shown at Fig. 4 can be made either with the pinion, F, and segment of gear, G, or as shown at H. The lever, H, contains a silk cord wound once around the pivot upon which the pointer is fastened. If the silk thread is used it should be soaked in melted beeswax to prevent the fuzz or fringe fraying out under constant use. In Fig. 5 is shown an attachment for indicating holes. I represents a sleeve having a tapered hole which fits the taper, J. The contact points, K K, are equidistant from center, L.

Fig. 6 shows an improved centering attachment, the improvement being the spring end, M. If the bar were solid and the pointed end were placed in the prick punch mark of the work on the faceplate, with the tail center placed in end, O, it is obvious that the prick punch mark would be distorted and its position changed when knocking the work to bring the prick punch mark central with the spindle. By use of the spring end on the bar in sketch, this difficulty is overcome since the spring compresses before the point of the bar distorts the prick punch mark. The reader probably knows that it is a disagreeable, uncertain job to indicate work with the old-fashioned so-called "wiggler." The vibration of the shop causes the needle point to constantly tremble, it is difficult to ascertain the "high point" of the needle when rotating the faceplate, and the "wiggler" seldom multiplies over 15 times. When using an indicator in connection with the bar shown at Fig. 6 for indicating a prick punch mark or hole, all that is necessary is to note how many graduations the needle has traversed and knock the work so that the needle will go back one-half that amount, and there you are almost at the first rap. In my opinion it is poor policy to use a prick punch mark for determining the exact center of a piece of work. To grind a button to some given size, fasten it the proper distance from the edges of the work, and then to indicate the button is a much more accurate way, for we have no assurance that the prick punch was driven in exactly where it should have been. True it may be very close, but the day of "somewhere near" has passed.

* * *

TABLE OF SPUR GEAR TEETH GIVING DIAMETRAL PITCH.

L. S. BURBANK.

There are plenty of good formulas giving the shape of gear teeth, size of blanks, etc., but I have often wished that there was a table of gear teeth giving the proper diametral pitch and face of teeth under various conditions so one might have it before him to see at a glance whether or not the ratio of teeth desired would admit of sufficient tooth-strength. Figuring the strength of gear teeth is, in many instances, somewhat unsatisfactory because the bother of choosing and applying one of the many varied and more or less complicated formulas does not justify the time spent, especially as the size of teeth is so often and so largely modified by the velocity ratio that to keep within a safe strength is often the main object. But to guess at it pure and simple is going altogether too much in the dark, although I have no doubt that more gear teeth are guessed at, *as to strength*, than are figured, if the truth could be known.

Why not have a table giving the diametral pitch directly for all gear teeth working within certain practical limits? Then all that need be done is to ascertain the tooth speed and the force or horse power, under which it works, and, from the table, read at once the allowable diametral pitch for an assumed proportional tooth-face, provided for in the table; the result, together with the velocity ratio already known, gives all the data necessary to make a drawing or sketch. Let us see what can be had for a table:

In Kent's Mechanical Engineer's Pocketbook under the heading of "Gearing" may be found an interesting comparison of some gear tooth formulas by various authors, made for the purpose of showing the variation in results, but favors, with good reasons, an empirical formula by Mr. Wilfred Lewis. This formula gives $W = s\ p\ f\ y$, where W is the load, in pounds, transmitted by the teeth; s, the safe working stress of the material; p, the circular pitch; f, the face of tooth, in inches; and y, is a factor depending upon the form, and number of teeth, and whose value for different cases is given in a table. The value for this factor, y, for a cycloidal tooth or a 15-degree involute tooth, which latter is the one most commonly in use, is given as ranging from 0.067, for a pinion of 12 teeth, to 0.124, for a rack. The working stress, s, for different speeds of cast iron teeth, is given as ranging from 8,000 pounds for a tooth speed of 100 feet or less per minute, to 1,700 pounds for a tooth speed of 2,400 feet. The gradation is given by a table as follows:

Speed.	100 feet or less.	200	300	600	900	1200	1800	2400
s	8000 lbs.	6000	4800	4000	3000	2400	2000	1700

If, in the above formula, the variable quantities could be reduced to two in number and the circular pitch expressed as diametral pitch, a very convenient table, such as I have mentioned, could be arranged: Suppose we let p_1 = the diametral pitch then $p = \frac{\pi}{p_1}$. Suppose also we assume the width of face, f, to be 8 divided by the diametral pitch; or $f = \frac{8}{p_1}$. This gives a very good proportion for the face and one easily determined afterward from the table.

$$\text{Then } p\,f = \frac{\pi}{p_1} \times \frac{8}{p_1} = \frac{8\,\pi}{p_1^2}$$

Substituting this value in the original formula we get

$$W = \frac{s\,y\,8\,\pi}{p_1^2}$$

from which

$$p_1 = \sqrt{\frac{s\,y\,8\,\pi}{W}}$$

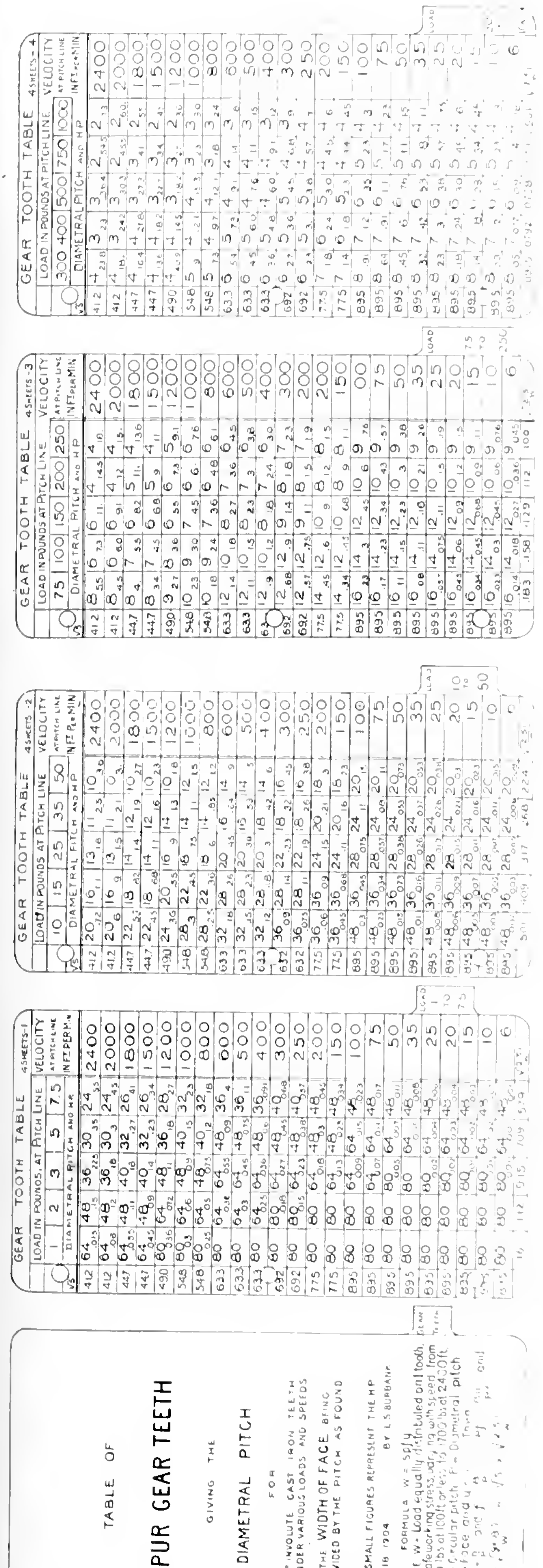
Suppose now, as the original formula can be only approximately correct, that we strike an average for the factor, y, as between 0.067 and 0.124, and call it 0.1. Then our formula stands

$$p_1 = \sqrt{\frac{s\,8\ \pi}{W}}$$

which we can separate into two factors and express it

$$p_1 = \sqrt{s} \times \sqrt{\frac{2.51}{W}}$$

In this formula the factor $\sqrt{s}$ contains the working stress



These Tables are Reproduced in their Original Form as presenting a good Example of Compilation of Engineering Data in Convenient Shape for Ready Reference

for tooth speeds and the factor $\sqrt{\frac{2.51}{W}}$ contains the load on the tooth.

Now we can easily arrange a vertical column from the ... preceding table, containing a series of values for $\sqrt{s}$ covering a convenient range of tooth speeds—say, from 6 to 2400 feet per minute—and likewise a horizontal row containing a series of values for $\sqrt{\frac{2.51}{W}}$ covering a convenient range of loads say, from 1 to 1,000 pounds.

Then from the products of these two sets of figures we can compile the desired table of diametral pitches. As these factors are preliminary, they need not necessarily appear in a working table. As the products of $\sqrt{s}$ and $\sqrt{\frac{2.51}{W}}$ (the loads and velocities) divided by 33,000 give the horse powers, I have included these (in the small figures) because of their addition to the value and convenience of the table. Some of these H. P. values are pretty small, to be sure, but none the less instructive.

Let us now take an example: Suppose we were designing a machine in which a belt wheel, running at 200 R. P. M., is to drive a pinion shaft whose pinion meshes with a gear running at 25 R. P. M., and we know, either by calculation or experiment, that the force, or load, on one of these gear teeth is 300 pounds. What are the proper dimensions of the gear blanks and what size pulley should we use, the distance between shafts being 18 inches?

The velocity ratio is 200 to 25 or 8 to 1. The sum of these ratio terms is 9. The diameter of the gear, on the pitch line would be $2 \times \frac{8}{9} \times 18 = 32$ inches. Its tooth velocity would be

$$\frac{32 \times 3.14 \times 200}{12} = 1{,}675, \text{ say } 1{,}500 \text{ feet per minute.}$$

The load we already know to be 300 pounds. Now, from the table we read at once the diametral pitch to be 4, and incidentally we see the horse power to be 13.6, say 14. The width of face is $8 \div 4 = 2$ inches and the outside diameter of the blank, by the well known rule, is $32 + 2/4 = 32\frac{1}{2}$ inches. The pinion blank is $4\frac{1}{2}$ inches diameter by 2-inch, say $2\frac{1}{4}$-inch face. The number of teeth in the gears are, of course, readily calculated, knowing the diameters and the diametral pitch. For the dimensions of the pulley we have given in the table the H. P. and we have simply to apply some belt formula such as H. P. $= \frac{DRW}{2750}$ and, if we choose a 6-inch belt, our pulley is 32 inches diameter. The horse power, as given is equally convenient in calculating sizes of the shafts, that is to say, the bores of the gears.

The table will be found convenient also in modifying the original tooth face in cases where it is desirable to use a different pitch from that given in the table. Where the pitch is chosen in the same horizontal line in which the original is found, it is simply necessary to multiply the tooth face, derived from the original pitch, by the ratio of horse powers corresponding to the two pitches; the original horse power being the numerator. The resulting tooth-face gives a strength equal to the original tooth.

For instance, suppose, in the above 32-inch wheel, that it were desirable to use a 5 pitch instead of the 4 pitch called for; the original tooth-face is $\frac{8}{4} = 2$ inches, as above, the horse power corresponding to the original pitch 4, is 13.6 and that corresponding to 5 (in the same line) is 9, the required tooth-face, therefore, is $2 \times \frac{13.6}{9} = 3.02$ inches, say 3 inches.

Where the desired pitch occurs several times in the same line, the average horse power may be taken.

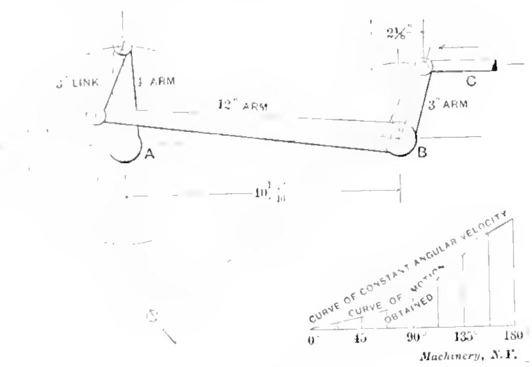
I trust that the above table will prove to be of practical value in many places.

LETTERS UPON PRACTICAL SUBJECTS.

LINK MOTION FOR ROTATING A SHAFT 180 DEGREES.

Editor MACHINERY:

We had a little problem which consisted of driving the shaft *A* through an arc of 180 degrees, or slightly over, without the use of gears, the movement to be reversible and without backlash. The driving shaft is not shown, but it operated by means of a crank, the rod *C*, shown in the sketch.



Link Motion for Rotating a Shaft 180 Degrees.

We accomplished our results as follows: A 4-inch lever arm was keyed to the end of the shaft *A*. A 3-inch link connected this lever to a 12-inch lever arm at *B*, whose center of oscillation was on the line bisecting the 180-degree arc and at a point 10 13-16 inches from *A*. The 12-inch arm is operated by a rod working on a 3-inch arm lever mounted on same shaft. The sketch shows the relative positions of the various parts after moving through the 180 degrees. The angular velocity of *A*, however, is far from constant, as may be seen from the accompanying diagram, in which the ordinates are proportional to the distance traveled by the rod *C* at the driving end. The straight line above the curve would indicate the curve for a constant angular velocity. J. D. ADAMS.

Phoenix, Ariz.

GRAPHICAL SOLUTION FOR BEAMS.

Editor MACHINERY:

In finding the modulus required in a beam to carry a given load over a certain span, the accompanying diagram has been found to be of value. To the left of the diagram will be found a column of spans in inches. Reading across the sheet we find the oblique lines for the various loads, from the intersection of which with the span line we read above or below, as the case may be, until we intercept the oblique line of the fiber stress to be employed. From the intersection thus found we read again to the right and find on that side of

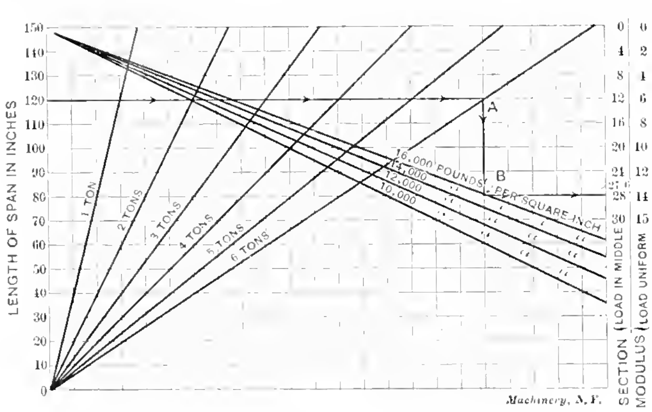


Chart for Graphical Solution of Section Modulus of Beams.

the sheet the correct section modulus to be employed for the different cases of loading as indicated. For example: What section modulus is required for a beam having a span of 120 inches and carrying a load in the center of 12,000 pounds when the fiber stress is limited to 16,000 pounds per square inch? The horizontal from 120 intersects the 6-ton or 12,000-pound diagonal at *A*; thence the vertical intersects the 16,000-pound fiber stress diagonal at *B*; and thence the horizontal gives the reading 27.6 in the first column at the right. It can readily be seen that in like manner a column of section moduli for the cantilever may also be added.

WALTER RAUTENSTRAUCH.

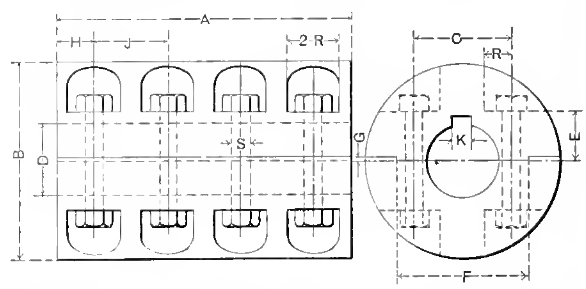
Sibley College, Ithaca, N. Y.

THE ADVANTAGE OF THE CLAMP COUPLING IN CEMENT MILLS.

Editor MACHINERY:

In mills where dusty or gritty products are handled machinery wears out rapidly and has to be replaced very frequently. In replacing such machinery it is very often desirable to do it with machinery of a later and improved pattern. This necessitates a continual taking down and putting up of shafting for the purpose of shifting or removing pulleys, gears and clutches. With the usual form of flange coupling this is quite a job as the couplings are hard to remove from the shafts and after they have been replaced and keyed on, the shaft has to be put in a lathe and the coupling squared up.

In our mill we frequently ran from one week's end to another with scarcely a stop, so the time left for repairs was very limited. We found the style of coupling shown with



D	A	B	C	E	F	G	H	J	K	R	S	WEIGHT LBS.
1 7/16	6	4 1/4	2 1/2	1 1/8	3 5/8	1/8	1 1/2		5/16	15/16	5/8	19.89
1 11/16	7	4 7/8	3	1 3/16	4	3/16	1 3/4		7/16	1 1/16	3/4	30.24
1 15/16	8	5 1/2	3 1/4	1 5/8	4 1/4	1/4	2		7/16	1 1/16	3/4	43.95
2 3/16	9	6 1/8	3 1/2	1 1/2	4 1/2	1/4	2 1/4		9/16	1 1/16	3/4	66.09
2 7/16	10	6 3/4	3 5/8	1 3/4	5	1/4	2 1/2		9/16	1 3/16	7/8	82.15
2 11/16	11	7 3/8	4	1 7/8	5	1/4	1 3/8	2 3/4	9/16	1 1/16	3/4	107.55
2 15/16	12	8	4 1/4	2	5 1/4	1/4	1 1/2	3	11/16	1 1/16	3/4	121.84
3 3/16	13	8 5/8	4 1/2	2 1/8	5 1/2	1/4	1 5/8	3 1/4	11/16	1 1/16	3/4	168.84
3 7/16	14	9 1/4	4 3/4	2 3/8	6	1/4	1 3/4	3 1/2	11/16	1 3/16	7/8	201.33
3 11/16	15	9 7/8	5	2 1/2	6 1/4	1/4	1 7/8	3 3/4	11/16	1 3/16	7/8	254.91
3 15/16	16	10 1/2	5 1/2	2 5/8	7	1/4	2	4	13/16	1 5/16	1	279.61
4 7/16	18	11 3/4	6 1/4	3	7 3/4	1/4	2 1/4	4 1/2	13/16	1 5/16	1	420.08
4 15/16	20	13	6 3/4	3 3/8	8 1/2	1/4	2 1/2	5	13/16	1 9/16	1 1/4	496.78

Machinery, N.Y.

Clamp Coupling Dimensions.

table gave excellent satisfaction. The smallest size of shafting used anywhere about the mill is 2 15-16 inches diameter and not a great deal of this size is used, but I have calculated the other sizes so as to have the table complete.

We always kept a number of extra bearings on hand and the millwright who looked after the line shafting used to mark the bearings that showed signs of wear. When for any reason it became necessary to shut down the engine for half an hour or so he would pull out the old bearings and slip in the new ones. The old ones were then babbitted at his leisure and were then ready for a new place.

Rutland, Mass. H. A. HOUGHTON.

TO TRUE UNIVERSAL CHUCK JAWS.

Editor MACHINERY:

The following is a description of a method which I have used and found very effective for truing the jaws of lathe chucks which have been strained or worn out of true to such an extent that they would not hold the work firmly. In most chucks there is quite a thickness of metal in the faceplate between the back of the jaws and the recess which is threaded to screw onto the spindle. If this has been drilled through to allow a rod of stock to be put through the hollow spindle of

the lathe, open the jaws far enough to clear, and true this hole up by taking a light smooth cut with a boring tool. Next take a piece of stock about 6 inches long, of sufficient diameter to leave a small shoulder and turn the end to a size that will be a nice running fit in the hole already trued in the chuck faceplate. Then turn the large diameter true for a distance slightly more than the length of the jaws, letting it taper about three or four thousandths inch, the large diameter being at the shoulder already turned. After oiling well, place the end turned down in the hole in the chuck and hold the other end in the tailstock chuck, if there is one belonging to the lathe; if not bring the tail center up, after first placing a dog on the lap, and adjust it so as there will be just sufficient end play to allow the spindle to revolve freely. You are now ready to begin lapping the chuck jaws true.

Place some emery and oil on the lap and close the jaws of the chuck until the longest one touches the lap; start the lathe on the high speed, holding the lap from revolving by means of the dog. Adjust the jaws from time to time until all of them are found to have a bearing on the lap their whole length. The advantage of this method is that if the jaws of the chuck are loose, when you screw them down on the lap they take the same position they would when tightened on a piece of work in the chuck, and when the job is finished if carefully done they will be found to have a parallel grip on a straight piece of work.

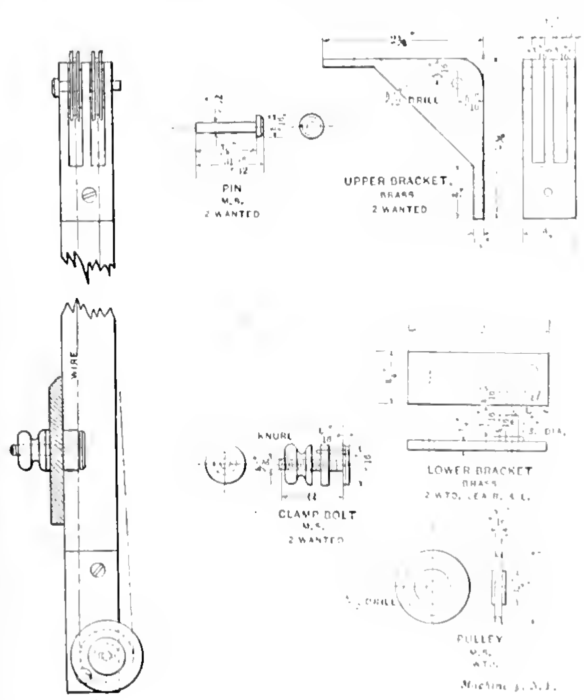
This method can also be used in truing up large chucks by placing the lap on the centers, being careful to keep the live center well supplied with oil. If, after truing the inside you wish to true the outside of the jaws you simply tighten the chuck on a perfectly round piece of stock and grind the outside with a grinding attachment. J. E. MANIFRRE.

New York.

PARALLEL MOTION FOR DRAWING BOARD.

Editor MACHINERY:

Seeing the description of parallel motion for drafting boards by V. A. H. in the August issue, I decided to send details of fixtures that I have on my drafting board. I have used this motion a good deal and consider it far ahead of any T-square



Parallel Motion for Drawing Boards

as it will stay where it is put, is of easy action and it needs no care to draw a line the full length of the board, as one end of straightedge is as firm as the other.

The wire (for I use music wire No. 2 instead of cord) is crossed on the edge of board away from the draftsman and passed over pulleys on each end. The ends of the wire are connected by a small spiral spring of sufficient stiffness to keep the wire under tension. An end of the board is shown at *A*, with straightedge fastened to wire. The straightedge can be slotted where clamping bolt passes through, which will allow it to be set at an angle if wanted. The upper corners of the board are cut away at an angle of 45 degrees to allow the upper bracket to set up to the board; the brackets are fastened to the board by common wood screws. The pins for the upper bracket are a snug fit in same and pulleys must have hole large enough to allow them to turn freely. A pin is forced into the lower bracket and a small hole drilled at *A* for a pin, not shown in detail, which is used to keep the pulley in place.

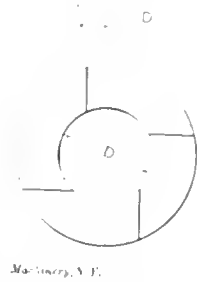
The board proper in my drafting table being but $\frac{5}{8}$ inch thick I have the brackets made $\frac{3}{4}$ inch wide, but they can be made any width, the idea being to have the upper wire on ends as nearly parallel with top of board as possible. I put a small pin through the head of the clamping bolt and its washer, to prevent it turning when tightening same. The dimensions of washer and dimension *a* are not given, as these depend upon the distance from upper wire to under side of straightedge and the thickness of the straightedge.

Athol, Mass. H. M. B.

REGARDING THE TEETH OF HOLLOW MILLS.

Editor MACHINERY:

I have read with interest Mr. Markham's articles in MACHINERY, and consider that they, in a general way, fittingly typify the art of toolmaking as it applies to the modern toolmaker and toolroom practice. While the articles in question are no doubt written for the beginners in their line of work, they can, I believe, be read with profit by the experienced workman as well. When it comes to the cutting of teeth in hollow mills, however, I take exception; from a careful reading of the article relating to this class of tools and reference to the illustrations, I come to the conclusion that he sets the face of the teeth in mills on a line with the center, or radially, which is different from what I have been in the habit of doing when making these tools for the machining of steel or cast iron.



Hollow Mill with Tangent Cutting Faces

While working in from fifteen to twenty shops I have had frequent occasion to observe the action of these tools, principally, for the rapid reducing of bar stock in the turning or screw machine work, and, from these observations I have been led to believe that the most noteworthy point to take into consideration is the proper cutting of the teeth sufficiently in advance of the center to insure a keen cutting edge and give somewhat of a side rake which is not possible to develop when the teeth are in line with the center. For brass, I always cut the teeth straight and on the center; for cast iron and steel, more especially the latter, we cut them spiral or straight, and for general practice ahead of the center. The rule I adopt when cutting the teeth is to set the side of the milling cutter from 5-16 to $\frac{3}{8}$ of the diameter of the hole in the hollow mill in advance of the center; the sketch gives an idea how it looks when finished. Clearance is given the mills in same manner as Mr. Markham describes, either by taper reaming from the back or by grinding internally; also we bevel the teeth when possible at the cutting end so that the tool may center itself and last longer. C. H. ROWE.

Worcester, Mass.

JIG FOR SPACING AND DRILLING HOLES AT A GIVEN ANGLE.

Editor MACHINERY:

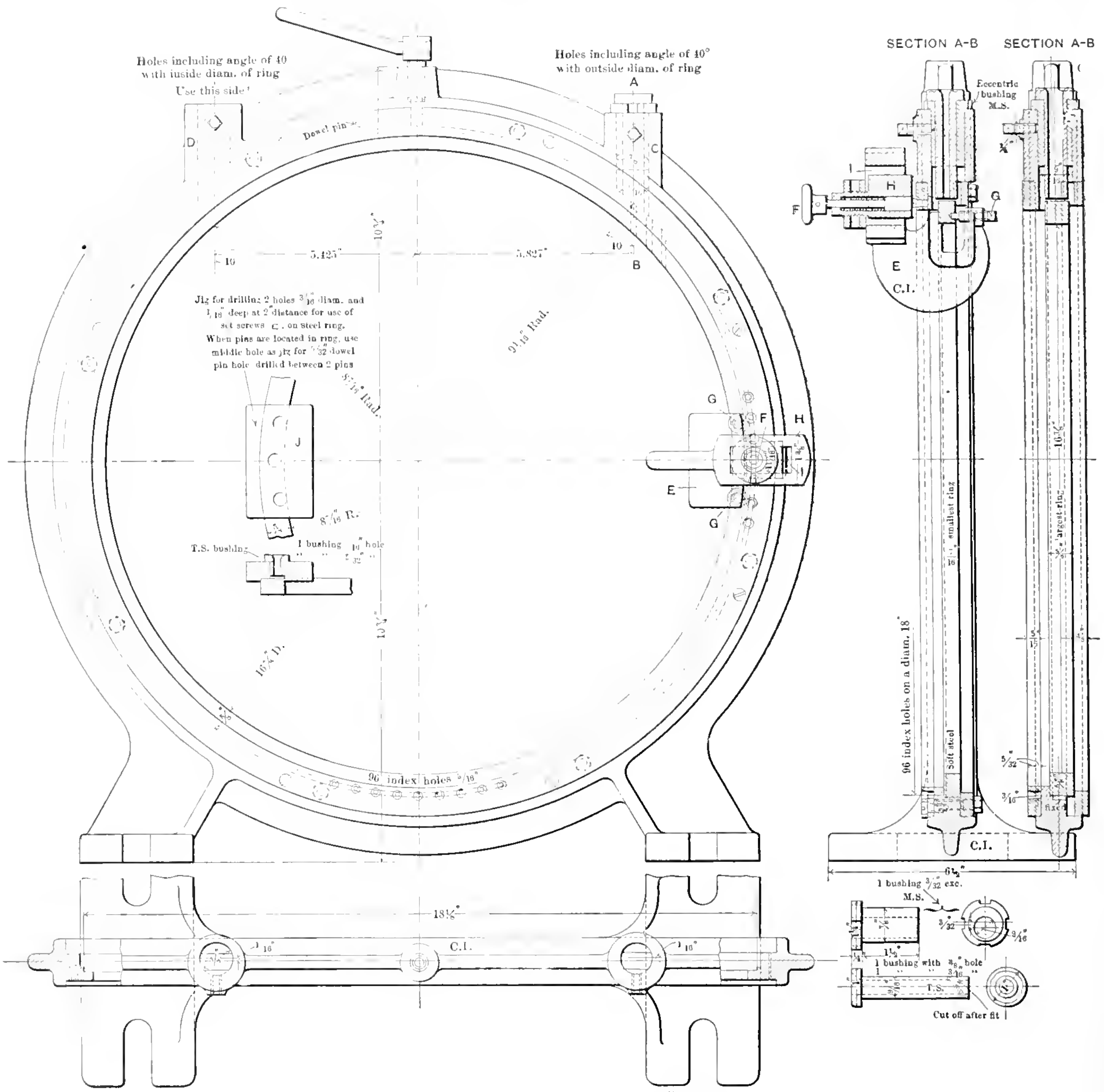
One of the most interesting jobs I have had to deal with recently, was drilling properly-spaced holes in soft steel rings at a given angle to the diameter, and a brief description of the operation, together with a drawing of the jig which was used, will I think, be of interest to your readers.

The rings to be drilled, in this instance, were $18\frac{1}{2}$ inches outside diameter, $16\frac{7}{8}$ inches inside diameter, by 7-16 to $\frac{5}{8}$ inch wide. The rings 7-16 inch wide, having 96 holes 3-16 inch in diameter, and those $\frac{5}{8}$ inch wide, 48 holes $\frac{3}{8}$ inch in

diameter, drilled, in both cases, at an angle of 40 degrees to the outside diameter of the rings. The jig body consists of a single casting, bored to receive the ring to be drilled, allowing it to rotate freely, and counterbored at either side for the indexing ring and the retaining, or cover ring, which is removed when the work is finished and a fresh ring is to be inserted. Referring to the drawing, it will be seen that the two bosses, *C* and *D*, which take the drill bushings, are not equidistant from the center line. This difference is necessary to compensate for the thickness of the ring (5/8 inch) and gives at *C*, the same angle to the outside diameter, as that which is obtained at *D*, to the inside diameter of the work, viz.: 40 degrees. To bring the drill central for different width rings, there is an eccentric bushing bored to receive the drill bushings, and made a wringing fit in the hole in the boss. A setscrew binds this bushing after it has been swung to the desired position by means of a spanner-wrench. This method of centering the drill changes the angle somewhat, but as all of the holes in one piece of work have the same angle, the result is satisfactory.

The indexing, or spacing of the holes is, really, the novel feature of this jig. This is accomplished by means of the separate fixture *E*, which is fastened on to the work much after the manner of a C-clamp. The two setscrews *G*, engage the two holes spotted on the face of the ring to receive them, and the taper end of the spring-pawl, *F*, engages the taper holes in the index ring. The block *H*, carrying the pawl may be adjusted in the slot *I*, to suit an index circle of different pitch diameter. The small jig *J* is for locating the holes for the setscrews in the indexing fixture, and the central hole in this jig is for drilling the dowel-pin hole in the work after it is finished and ready for assembling. JULIUS LENHART.

Philadelphia, Pa.



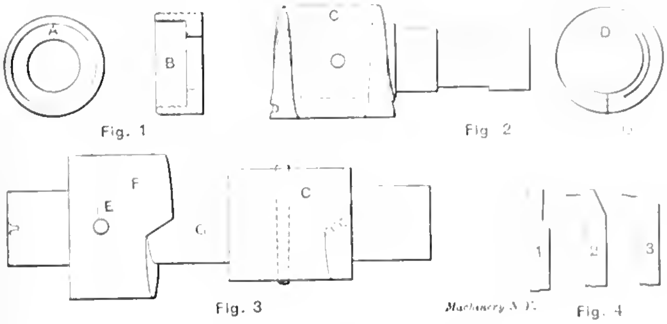
Jig for Spacing and Drilling Holes at a Given Angle.

MAKING FORMED CUTTERS ON THE LATHE.

Editor MACHINERY:

I send you some sketches of a rounding tool, which, although it is not new, may interest some of the readers of MACHINERY. The tool was made to round the outer rim of a cup-shaped piece, Fig. 1. The sectional view, *B*, shows the rounding of the outer rim. The material being cast iron and fairly thin, they come hard as a rule, and a mushet tool had previously been used for the rounding. The grinding and keeping in shape of the mushet tool was generally unsatisfactory, and it was decided to make the tool shown in Fig. 2, in two views, *C* and *D*. The tool consists of a hollow shell fitted to a shank for a turret holder. The shell, it will be seen, is a double-ender, so when one end has been used up it can be reversed and the other end used, thereby making two tools in one. The shaping groove is slightly

flared out so as not to leave a square shoulder as the cup is finished all over. A tool of the above description is somewhat out of the ordinary line, requiring some special fixtures for its shaping, but it is, nevertheless, not hard to make, and for the benefit of some of the readers I will give a brief description of how the one in question was made.



Making Formed Cutters on the Lathe.

A cast iron piece somewhat larger in diameter than the forming tool was bored out the same size as the other and fastened to a soft steel arbor, made for that purpose with a setscrew, *E*, Fig. 3. This was placed in a universal milling machine and a cam cut out on the end of the cast iron piece with a lead of ⅝ inch to one turn; the short part of the cam was dressed off with a file to the proper shape. The blank cutter was then placed on the same arbor and secured with a taper pin. With the work mounted as shown in Fig. 3, the arbor was placed on the centers of the latho and driven with a dog in the usual manner. A piece of 1-inch square iron, *H*, Fig. 5, was drilled for a bolt in the middle and a ⅝-inch pin at the end and at right angles to the bolt hole. This piece was bolted to the outer edges of the toolpost saddle. Another piece, *L*, of the same section but somewhat longer was drilled a loose fit for the pin, *M*, and a smaller pin, *N*, was put through the piece, *L*, and the ⅝-inch pin, *M*, to form a hinge on which the piece *L* might swing. The other end of the piece, *L*, was turned down to receive a roller, *K*. The roller was made crowning with a radius equal to the distance from the center of the roller to the pin *N*. A feed screw, *J*, was tapped through the end of the piece *L* and the point was sunk into the piece *H* for support. A rope, *P*, was fastened to the carriage and run under the headstock and over an idler sheave fastened to the gear bracket. A weight, *W*, was fastened to the rope to keep the roller, *K*, against the cam; the apron of the carriage, of course, was disconnected.

The first operation was to trace the outline of the cam on the cutter blank with the tool No. 1, Fig. 4. The blank was then taken off and where the short rise of the cam takes place a few holes were drilled, indicated by the dotted circles in Fig. 3, and the rest of the stock was taken out with a file. This was necessary in order to relieve the tool of the scraping action when being forced out by the cam. The outline of the cutter was then cut by feeding in the cross-slide carrying the tool No. 1, several cuts being necessary. The roughing tool No. 2 was next used, the relative position of this tool and the finishing tool No. 3 with the roller *K* in starting the cut, being shown in Fig. 5. These tools are sunk into the blank by placing a wrench on the feed screw *J* and giving it a slight turn to the left for every turn of the cam. In order to relieve the tools Nos. 2 and 3 of the top scraping out, at the rise of the cam, a hole is drilled at the end of the groove, as shown at *O*, Fig. 2.

One end of the forming tool being completed, the taper pin was removed and the blank reversed. The short incline of the cutter is left until after the hardening, when it is ground for cutting.

CHARLES THIEL

Lawrence, Mass.

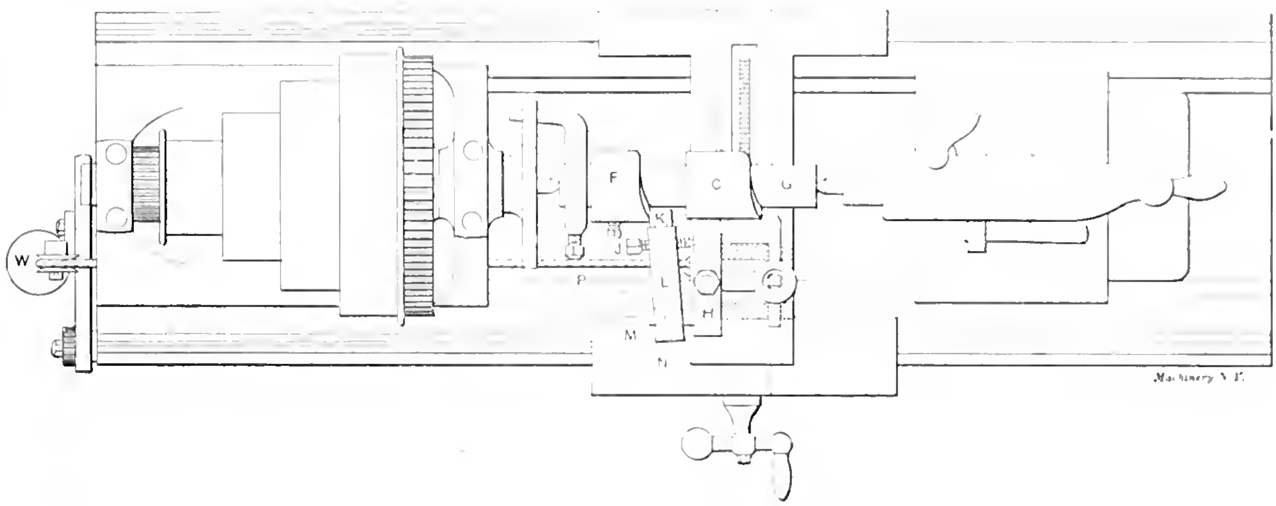


Fig. 5 Lathe "Set-up" for Making Formed Cutters.

LATHE RIG FOR TURNING MACHINE HANDLES

Editor MACHINERY:

I had the pleasure of rigging up an old engine lathe some time ago for the purpose of turning machine handles used in the construction of various machines, and it seemed to me it was a very neat and cheap way of obtaining the required shape, as well as finish necessary to make a good machine handle, although this method may have been employed for the same purpose before.

Fig. 2 shows sample of machine handle to be finished—swung between centers and driven by dog, *K*; the taper attachment is used with the taper bar, *T*, Fig. 3, clamped so as to be in a parallel position with spindle of machine and planed out so as to allow plate *B*, Fig. 1, to be screwed and doweled upon its surface. The former plate is laid out from the outline of the handle *A*, and the curve is generated by using, in this case, a one-inch roll. Fig. 3 shows tapped holes with eyebolts *L* inserted in the toolpost slide *E*, and also in carriage *F*.

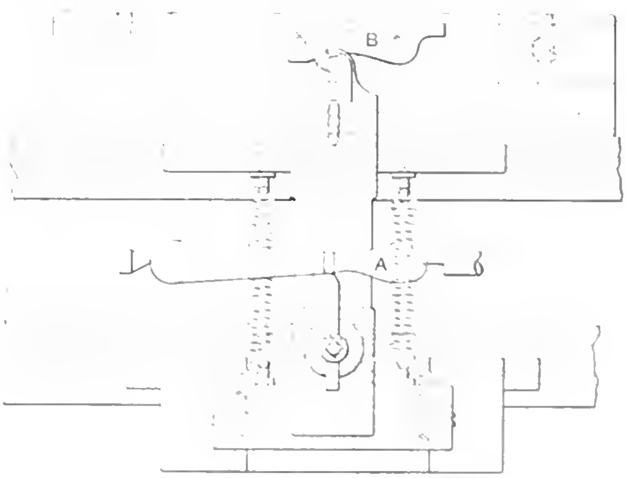
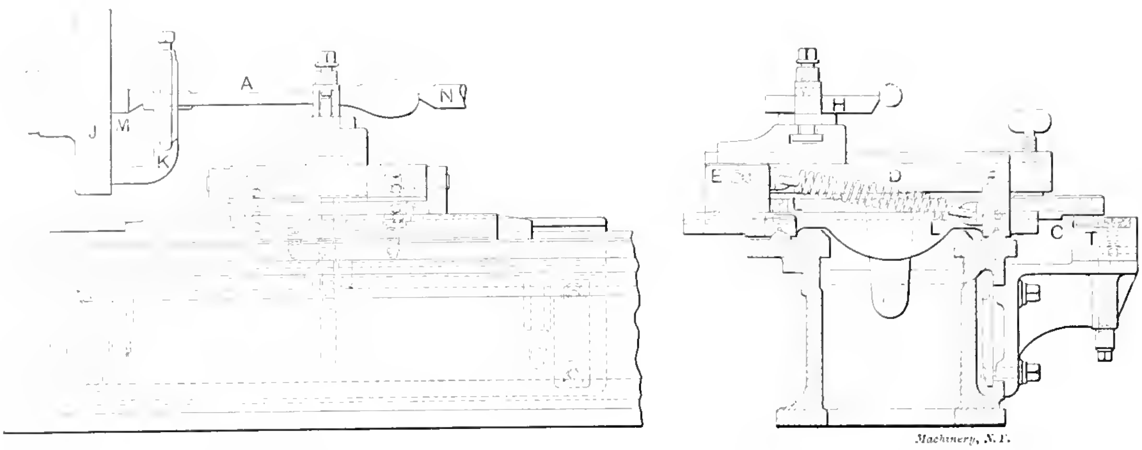


Fig. 1 Lathe Rig for Turning Machine Handles

With these two points connected with coil springs, *D*, which

hold the roll C in contact with the face of the former plate B, Fig. 1, tool H with the proper feed applied through lead-screw, follows the outline of the former, thus giving the required shape of handle. With a former plate for each size handle, the outfit is complete.



Figs 2 and 3. Side and End Elevation of Lathe Rig for Turning Machine Handles.

Of course this method is not limited to this class of work alone. It may be used for many kinds of forming work, where a large enough quantity is required to make it pay to make former plates. DRAFTSMAN.

HOW THE PILLOW-BLOCK SEAT OF A LARGE ENGINE WAS PLANED OUT WITH A SMALL PLANER.

Editor MACHINERY:

E. J. Buchet.

The accompanying photographs, Figs. 1 and 2, show how we had to do a heavy job of planing in a shop equipped with small tools. The job in question is an engine bed weighing 12 tons, which had to have a seat planed out at right angles for the pillow-block. As no planer in the shop was large enough to carry the job, the alternative was adopted of making one of the planers act as a shaper, but the first thing to do was to get the casting into position. No cranes being available, the casting was mounted on rollers like those used for house moving. The chain was made fast to one end of the bed and a long rope fastened to it, was wound round the table of a 10-foot boring mill. Then the boring mill table was started up,

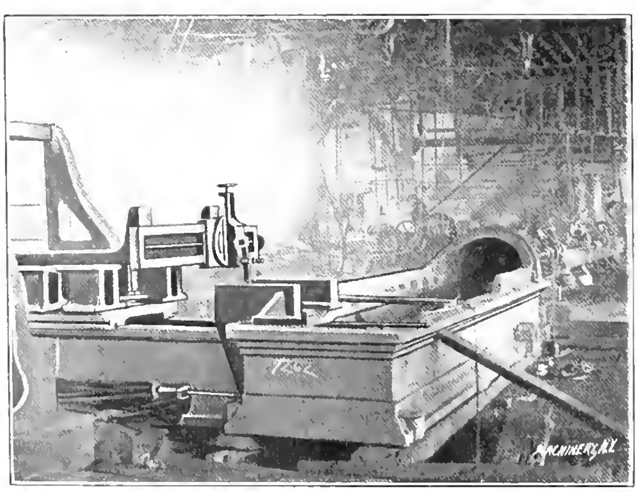


Fig 1. Planing Pillow Block Seat with Small Planer.

and the engine bed pulled into position behind the biggest planer in the shop. Here it was lined and leveled crossways to the travel of the planer platen, and a short distance below it. The cross-rail was taken off another planer and bolted to the back of the planer platen by means of angle irons. The cut was taken on the backward stroke of the planer platen. A very good job was done in this manner and in a reasonable length of time. E. J. BUCHET.

Dubuque, Iowa.

ERNEST J. BUCHET was born at Dubuque, Iowa, June 2, 1870. His early education was limited to common schools. He served a four years' apprenticeship with the Novelty Iron Works, and besides this concern he has worked for the Iowa Iron Works, the Chicago, Milwaukee, and St. Paul Railroad, etc.

"FRICTION OF SLIDING KEYWAYS."

Editor MACHINERY:

Your very instructive article, "Friction of Sliding Keyways," in MACHINERY for November reminds me of serious trouble I had many years ago. I encountered the defects of splined driving shafts in their most serious form, viz.: in heavy tapping machines for pipe threads. In those days tapping six-inch pipe threads was something to boast about; and it really was—when you tried to get a splined shaft to follow such a tap. Generally, when the tap took hold, the wheel on

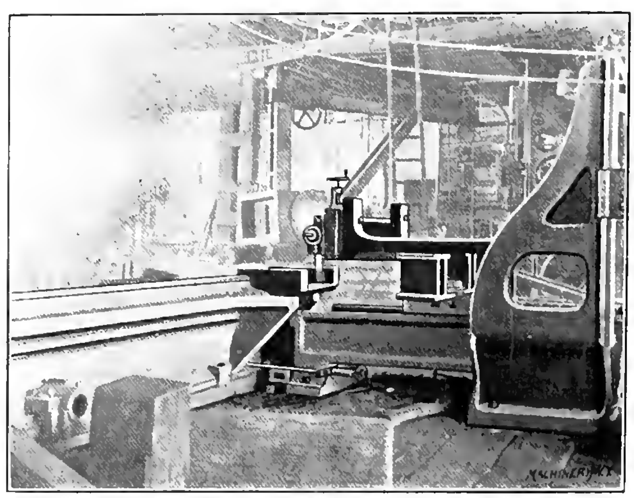


Fig. 2. Planing Pillow Block Seat with Small Planer.

the main spindle did just the same thing; then as the tap led into the work it was either torn out of the chuck or the whole table of the machine was lifted. Twenty-one years ago I had reached the point of building machines for my own use and met the difficulty as follows:

In Fig. 1 (next page) a portion of a heavy tapping machine is shown, enough to show the spindle action. In the great wheel A, a key like N, having radial sides, is driven in fast, but is a sliding fit for the spindle C, which has the keyway cut full length. Wheel A has a clamp hub, and this along with the clamp collar D, permits the spindle C to be set to any height suitable to the work on hand. When set, wheel A and clamp collar D are practically solid parts of spindle C, and grasp the square rack B, in which the spindle rotates. This rack B is actuated by a pinion in rear of bearing J, giving feed as per L.

As the spindle C is fed down to its work the wheel A goes along, traveling on the long pinion E, which is the driver. Pinion E receives power through bevel gear F, from back

gearing. So A, B, C, D and G move as one piece, balanced by wire ropes, M M, passing over pulleys. Solid black represents section through bearings in machine frame; section O being in another plane to take the pinion E behind the great wheel. This also allows cross beam G, which is fastened to the top end of the rack B, to pass over wheel F, till it strikes top of bearing J, as indicated by feed distance L. This combination follows an eight-inch tap without any noticeable drag. Apparently it is because the teeth of E and A are in constant motion on each other and, therefore, the downward motion of A on E is only compounding the movement of translation. Fundamentally, however, it is caused by the fact that the pressure on the teeth of A and that on the key in its hub, vary inversely as their distances from the center. That is, this method of driving reduces the drag of the spindle as much as C is smaller in radius than A. In these machines the great wheels are about eight times the radius of their spindles, but the advantage is greater than this for, since the key is fast in the wheel A, the spindle C would be driven by *less* than its radius, so that the ratio between dragging the spindle C over the key, or allowing A to travel on the long pinion E would be at least ten to one in favor of the system as described above.

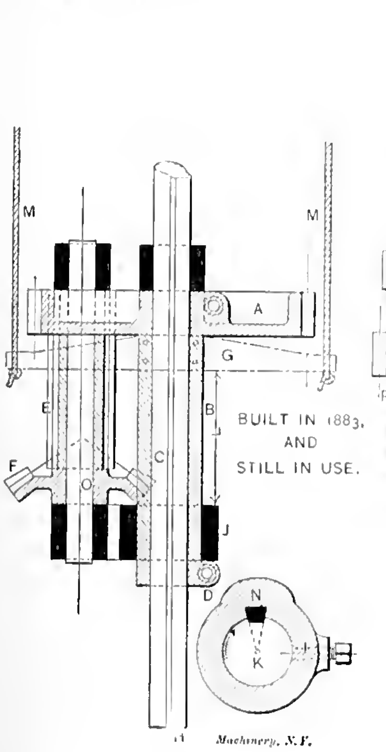


Fig. 1.

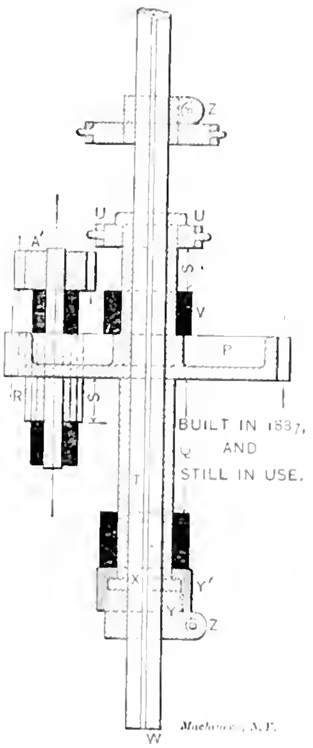


Fig 2

All chucks and taps are fastened to the spindle at H, by sockets, as shown at N I, the flat pointed setscrew at I serving merely to keep the piece from dropping off, since all the driving is done by the radial side key N. The absence of any socket, screw, or hole in the end of the spindle at H is just the very thing which makes it universal. This system by which the great wheel moves *along* the driving pinion E, combined with a spindle having a plain end H, I have been unable to improve to this day. All taps above three inches have this hub and dovetailed key N as part of the tap, so that the spindle of the machine becomes the stem of the tap. Those interested in this "reverse-stem" method of holding taps are referred to photograph of our taps in MACHINERY of January, 1900.

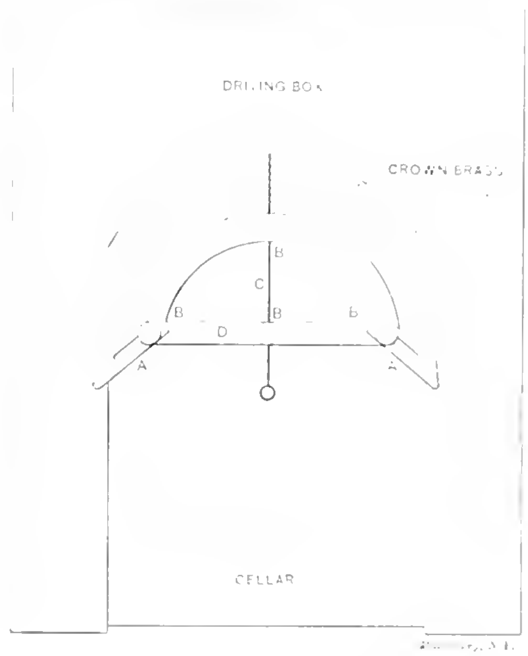
Most of this description also applies to a later machine of 1887, shown in Fig. 2. In this case the great wheel P has a long hub, as shown, and is a sliding fit on spindle T, and is a little overbalanced by a forked lever, the ends of which are shown at U U. Hence it normally remains up against bearing V, as shown; but when the tap takes hold it "bites" the spindle T, and travels with it, through the short spaces S, S which are more than long enough for a pipe thread tap. The instant the tap lets go, the great wheel P, automatically moves up to the position shown in sketch. So unobtrusive and quiet is this action that the average operative in using the machine does not even know of its existence. In moving the spindle over the range of the feed as per distance Q, no downward motion of P takes place, *unless we put work on at* W, when instantly P becomes practically a part of spindle T, and moves along with it. Rack Q in this machine is circular and has a flange on the lower end at X. The pieces Y, Y' may be considered as a solid piece. Spindle T is very long and is balanced by a forked lever as shown, and by shifting clamps, Z, Z, it may be let down to do work lying on the floor. Power comes through the spur gear A', from vertical back gearing. This machine, in action, is just the same as the machine shown in Fig. 1, but the gearing is more compact. The older machine has the advantage in that its great wheel will follow the whole range of the feed, and will therefore take a greater range of work outside of tapping pipe threads.

JAMES ARTHUR,
New York. President The Arthur Co.

TOOL FOR LAYING OUT CROWN BRASSES.

Editor MACHINERY:

Having been helped at different times by short articles and descriptions of tools appearing in your journal, I submit to you a brief description of a tool I both saw and used in one of the shops of the N. Y. Central. To a railroad machinist the drawing will almost explain itself, but to those not of that "fraternity" I give a description which I hope may suggest some other use to which this tool may be put.



Tool for Laying Out Crown Brasses

The tool consists of eight pieces, as follows: Two blades A A, four thumbscrews, B B B B, a scriber C and the body D. The cut shows plainly how it looks when assembled. The work it is designed to do is common in railroad shops in fitting a crown brass to a driving box. To use the tool proceed as follows: Place the two blades A A so that they fit against the flange as shown in the drawing, see that they set at the same angle, then clamp in position; now move the scriber C until it touches the box as shown. This finishes the measuring of the box proper. To transfer the measurement to the crown brass we proceed to lay a scale along the outside of the brass, place the scriber so that it just touches the scale, then scribe along the outside edge of blades A A and the brass is ready for the machine. This saves a good deal of time over the old method in vogue in many shops.

R. G. D.

* * *

The so-called indelible or aniline pencil is said to be effective for numbering or marking negatives, being used for this purpose on the undeveloped plates. A Stamford photographer says that he has found Dixon's "Eterno" to be the best for this purpose, as its writing is unaffected by the developing or fixing baths.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

HOW A TRIPLE WORM WAS CUT.

Some time ago I was required to make a worm which was to be used on a wire-measuring machine, and as the method used in cutting the worm was a little out of the common it will perhaps be of interest to the readers of MACHINERY. It was made of bronze with a triple V-thread 3½ threads per inch, or 3-10 lead. While calculating the gears to be used in cutting the worm, I found, as there were 3 1-3 threads in one inch, that this trebled would be 10 threads in one inch, and it occurred to me that all other threads could be cut at once using a 10-thread chasing tool, which I did, making a very neat accurate job and saving a great deal of time. The lathe used was a Reed lathe with 5-thread leadscrew. The nut was released at will and all the cuts taken without stopping the lathe. R. B. CASEY.

Schenectady, N. Y.

TEST GAGE FOR MAINTAINING STANDARD TAPERS.

In steam injector work the requirements for accurately ground reamers of unusual tapers are severe, and the gage shown in the sketch was designed to maintain the prevailing standard. It consists of a graduated bar 1 inch square, with the slot F, Fig. 1, running its entire length. The stationary head, A, is secured in position flush with the end of the bar, and the sliding head, B, is fitted with a tongue which guides it in the slot. This head may be secured in any desired position by means of the knurled thumb nut. The bushings, D

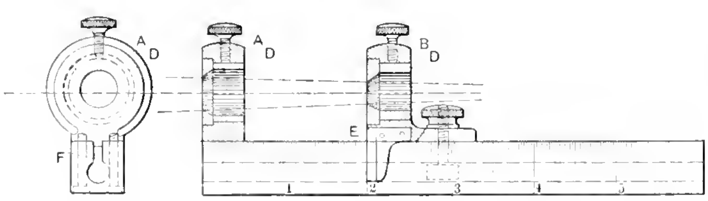


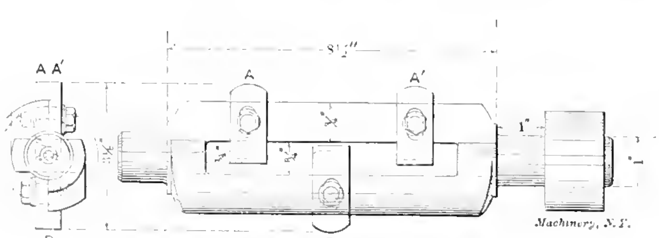
Fig. 1. Fig. 2.

and D' are made of tool steel, hardened and ground to a knife edge on the inside, flush with the face. All bushings are made interchangeable as to outside diameter.

The head, B, is fitted with an indicating edge, E, which is set flush with the knife edge of the bushing. The reading indicates to .01 inch, the distance the bushings are from each other, and the difference in their diameter being known, it is easy to compute the taper. With this gage it is possible to maintain the standard tapers to a fine degree, each reamer being marked with the reading as shown by the scale. I. B. NIEMAND.

WIRE STRAIGHTENER.

In answer to a request from one who signs himself "Connecticut," asking for information in regard to a wire-straightening machine, I would say that we are using a device which is giving satisfaction. The sketch sent herewith, showing some of the dimensions, which may be varied to suit condi-

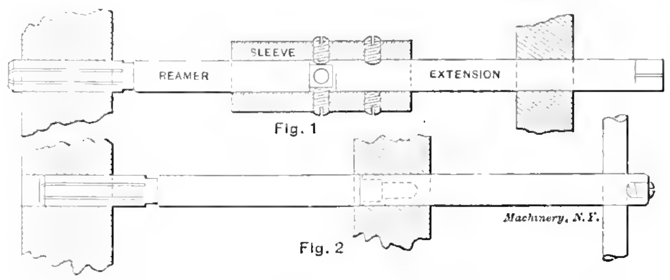


tions, gives a general idea of what it is. We can straighten any size wire in this machine up to ¼ inch in diameter. The lugs A, A' and B are movable and A, A' should be set at about the center line of the machine. The lug B, should be set in past the central line about ¼ inch making a short bend in the wire. Now, by placing the wire to be straightened through the central hole in the journals, grasping it with a pair of pliers and starting the machine, which should run at about 1,000 revolutions per minute, the wire with a slight pull will come perfectly straight from the machine. The lugs A, A' and B, should be concaved or rounded out on the ends where the wire bears, and should be hardened. E. B. KINGSLEY.

East Syracuse, N. Y.

TWO REAMER EXTENSIONS.

How many times have I wanted a specially long reamer to reach through two holes which were a distance apart! As I was walking through the shop a few days ago I saw a man using a simple extension which filled the long-felt want, and it is so simple and easy to make that I considered it worthy of the attention of your readers. The sketch, Fig. 1, will speak for itself. One screw is sunk slightly into the extension shank to prevent slipping while four screws form a

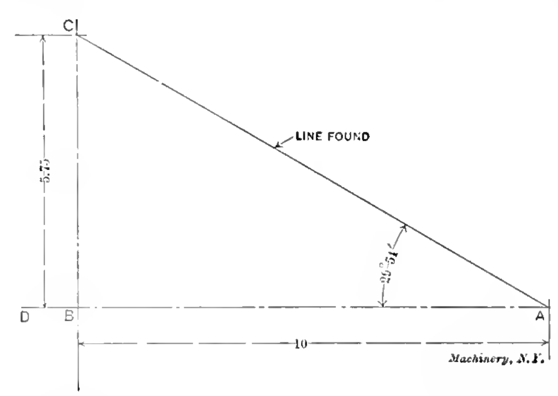


square place in the sleeve to take the square end of the reamer. The sleeve may be made from any kind of a piece of scrap iron, by simply drilling a hole through it the size of the reamer shank. The extension is merely a piece of shafting the same size as the reamer shank. Any ordinary tap or reamer wrench may be used on the square end of the extension. Fig. 2 shows another tap and reamer extension which will suggest to many machinists a good, practical tool for every-day use especially on the general run of jobbing work.

Pearl River, N. Y. H. E. WOOD.

TO LAY OUT ANGLES FROM A TABLE OF TANGENTS.

The diagram illustrates an accurate way to draw without a protractor lines at any angle wanted. Suppose we wish to draw a line at a certain angle with another and take for example 29 deg. 54 min.: First we draw a straight line, A D, of indefinite length and measure off 10 inches on the line from A to B; then find in a table of tangents, etc., the tangent of 29 deg. 54 min., which is .57503 for a radius of 1. For 10



inches it would be $.57503 \times 10 = 5.7503$ or 5¾ inches. Measure 5¾ inches from B to C at right angles to line, A B, draw a line from A to C, and we have the angle 29 deg. 54 min. This gives results more accurate than many of the protractors. ARTHUR W. MCALPINE.

Auburn, N. Y.

[Conversely, the angularity of two lines may be found by measuring the tangent and finding in the table what angle it corresponds to.—EDITOR.]

A NEAT SCREW DRIVER.

I send herewith a sketch of as neat a screw driver, for all-around shop use, as I have seen yet. This was first introduced in the shop by one of the tool makers. A, Fig. 1, rep-

resents a handle made of cold-rolled stock, is made hollow to lighten it. The knurling gives the hand a good grip. It will not split or become soaked with oil as the ordinary wood handle does. In finishing the hole *B*, if we use ¼-inch, 5-16-inch, or any standard hand reamer, it always gives a taper of about .005 inch at the front end, which makes it convenient

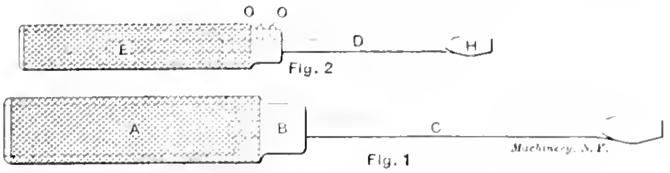


Fig. 2

Fig. 1

for a driving fit for *C*, that is, if the reamer is only run in flush with the end of the hole. The smaller screw driver, Fig. 2, is also a convenient tool. The blade, *D*, can be made to fit different-sized screws by making end *H* stronger and larger than *E*. *D* may be reversed by loosening the screws *GG*. PATRICK J. KING.

South Boston, Mass.

MILLING SQUARE JAW CLUTCH TEETH.

By using an odd number of teeth in designing the square jaw clutch it can be milled with only one setting of the cutter and one revolution of the index head.

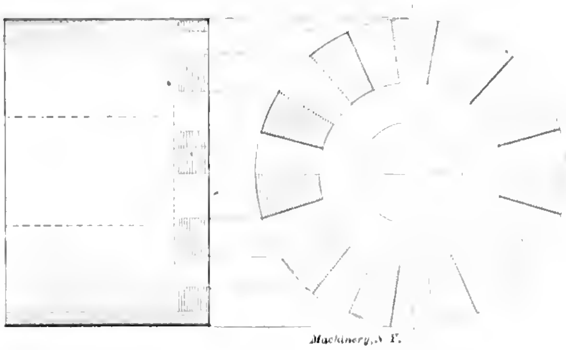


Fig. 1.

Fig. 1 shows one-half of a clutch with an odd number of teeth and Fig. 2 the method of cutting them. Bring the side of the cutter to the center line and cut space, *a* and *a'*, index and cut space, *b*, and *b'*, and so on; when half way round the cutter will only have the corners, *c*, to cut (shown dotted).

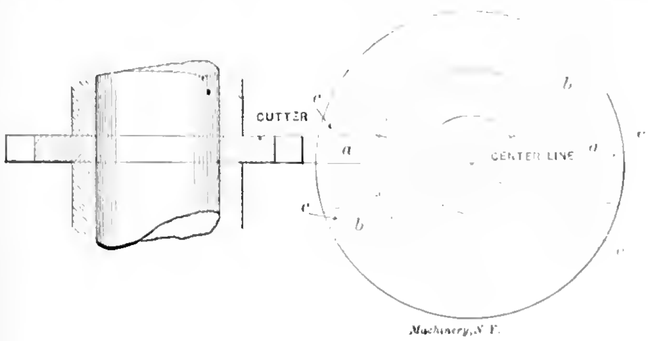


Fig. 2.

The cutter must be small enough to pass through the narrowest part of the space, but need not necessarily be that size. By moving the cutter 0.002 inch across the center line, the clearance between the teeth will be 0.004 inch.

Cleveland, O. DRAFTSMAN.

SIMPLE DRILLING JIGS FOR SHAFTS—WINDING SPRINGS—CUTTING OFF STOCK IN ENGINE LATHES.

The following kinks are some that I have found useful in the shop and I trust that they will likewise be of value to some of the readers of MACHINERY. The first is a jig for drilling shafting which requires two or more holes in a certain fixed relation to one another a considerable distance apart. This scheme requires as many blocks, *A*, Fig. 1, as there are holes to be drilled in the shaft. They are plain rectangular blocks, drilled and tapped on the sides for setscrews and bored for the shafts and drill bushings, as indicated in the cut. These blocks are slipped over the shaft to their proper locations and allowed to adjust themselves by setting on a surface plate or planer table, where they all take their positions automatically. The setscrews are then tightened and the holes drilled. Should it be required to counterbore the holes, the drill bushings may be made removable, and with their outside diameters slightly larger than that of the counterbore.

The second kink is for winding springs in the lathe. A forked holder is made for the toolpost, and is provided with two rollers of the general shapes shown at *A* and *B*. Roller

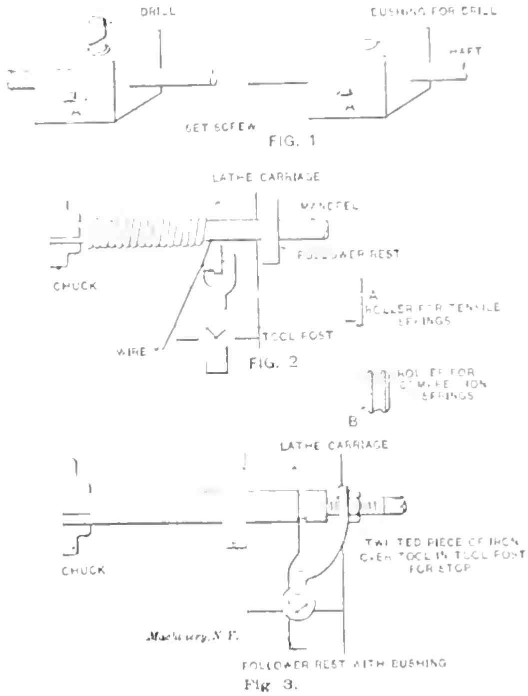


FIG. 1

FIG. 2

Fig. 3.

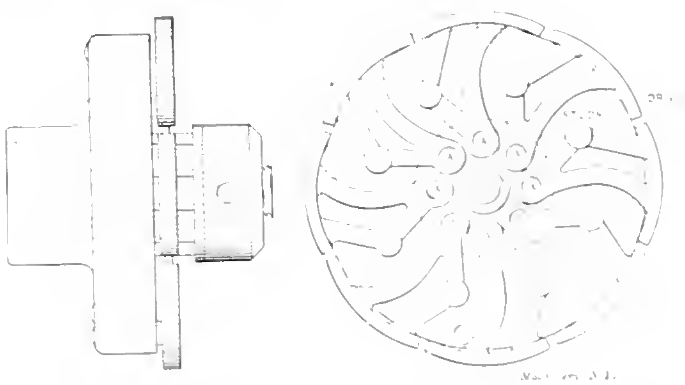
A is used for winding tensile springs, the carriage being moved along by the winding of the spring on the mandrel as indicated in the cut, Fig. 2. For winding compression springs, the carriage is fed by the screw cutting gear set to the proper pitch, and the roller, *B*, is used in the forked holder. A roller with a V-groove does not work as well as the half-round groove shown at *B*.

Fig. 3 shows how stock can be cut off in an engine lathe fully as quickly as in a screw machine. The cut shows the method so clearly that I think it requires no further description. HERMAN JOHNSON.

New York.

FACING SEGMENT GEARS.

We had a large number of drop-forged segment gears to finish. The drilling, reaming and facing of hubs were done first; next they were driven on an arbor, and the sides of rim faced. We used a straddle tool with inserted cutters on this

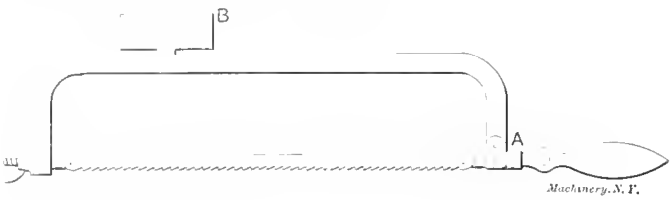


job, facing both sides at once. To watch this tool standing idle for about three-quarters of the revolution was aggravating, and in order to avoid this loss of time I devised a fixture like the accompanying sketch. The segments are slipped on the studs, *A*, and against the driver pins, the large nut holds them firm. By using a gear cutter that cuts the teeth to length at the same time they are shaped, the turning of the outside of the segments was made unnecessary. H. G.

Cleveland, O.

USING A HACKSAW AS A PARTING TOOL IN THE LATHE.

Having a number of pieces to saw in a hurry, I placed one in the power hacksaw and started it going and then fitted up a common hacksaw so that it was used in the lathe with great success on another piece. A ½-inch hole was drilled through the handle at *A* and a small weight was put on at *B*. A ½-inch arbor was clamped in the tool post parallel with the ways, and the hacksaw mounted on it by slipping it through the hole *A*. The work was caught in the chuck, and as it



rotated under the saw the cross-slide was moved across slowly as the sawing proceeded. I have since used this scheme more than once with good results, especially on any piece that has a hole through it. The saw does not work so well on solid stock as it is liable to break as it nears the center. I cut small gears or pulleys in halves in this way in a fraction of the time required with a parting tool, and with very little loss of stock. The weight required is small, being not over 8 or 9 ounces. ROBERT B. OTIS.

Orange, Mass.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

The following questions are referred to the readers for answers:

15. S. H.—Can you inform me of some solution for cleaning highly polished iron or steel?

16. L. M.—What is a good preparation to put upon zinc or tin sheets so as to make a good and permanent black or dead flat surface for templet work?

17. E. H.—What are the best methods, tools, etc., to use in turning off granite rolls of about 8 inches diameter by 10 inches long, having a 1½ inch hole through them, and properly affixed to a permanent shaft?

18. T. T. V.—We have experienced much difficulty with the thick, hard scale left on crucible cast steel after the annealing process. The acids we have tried, though they remove the scale nicely from forgings and cast iron, leave thick, hard patches on the crucible steel apparently untouched. These patches are of course very destructive to the cutting tools. Can you perhaps inform us of a process that will entirely remove the scale?

19. M. M.—I have tested the solution for which a formula was given in this department in the September number, for a non-corrosive soldering fluid, and find that it does excellent work. The expense of the preparation is an objection in my case, however, and I would like to inquire of your readers if there is any other less expensive compound for the purpose. Could the grain alcohol be diluted or some other ingredient be used in its place?

Answer to Question No. 3.

In the September number was an inquiry by H. J. N. regarding the use of aluminum for gas or gasoline engine castings. He wished to know whether an aluminum mixture could be used for the bedplate or other castings. This is replied to by R. M. W., who says: "I have found the best composition of aluminum for bedplates, etc., to be McAdamite, made by the McAdamite Co., New Brighton, S. I. It is much stronger than any other aluminum alloy I have had anything to do with. It has the same ring as steel and when broken the fracture has the same appearance. I hardly think it would be suitable for cylinders as its melting point is about 1,000 degrees, the same as that of pure aluminum. The composition is a secret, but H. J. N. could probably get fuller information by writing direct to the firm."

20. Subscriber.—Is it considered good practice to run steel gears at 1,200 to 1,300 feet per minute when used in machine tool construction? Should both gears be of the same or different material, and if both are of steel should both be hardened?

A.—We referred this question to the Boston Gear Works who replied: "We should consider the speed mentioned by your subscriber as the extreme limit for durability. We would suggest that gears running at this speed would probably give better results by having them casehardened. We should not consider cast iron suitable for the purpose, as the gears would probably wear rapidly. Neither should we consider that steel gears would wear well if of soft steel not hardened. It would be better still to have the larger gear of hard brass, and the smaller one of a good quality of steel not hardened. If well lubricated, we believe that good results could be obtained at the speed mentioned."

21. C. G. R.—Can you tell me where I can get information about the transmission of power by frictional gearing, like the Evans friction cone and similar devices? Is there any book published on this subject?

A.—There is no single book treating on this subject, but reference will be found to transmission by frictional gearing in works on machine design, notably Unwin's and Reuleaux's. The best information that we have, however, is to be found in a contribution upon "Paper Friction Wheels," by W. F. M. Goss, in the transactions of the A. S. M. E. for 1897. Prof. Goss conducted a series of experiments by means of two pulleys held in frictional contact, one an iron pulley, and the other of compressed strawboard. In accordance with the usual practice of selecting the yielding material for the driver, the strawboard wheel was made the driver and the iron wheel the follower. The driver was on a shaft with a belt pulley from which it received its power, and the follower was connected with a band brake for measuring the power transmitted. As a result of the experiments he gave a formula for H. P. transmitted, which is reproduced below. Let d = diameter friction wheel in inches; w = width of face in inches; N = revolutions per minute. A coefficient of friction of 0.2 is assumed, and a pressure of 150 pounds per inch width of face at the contact surface. Then,

$$\text{H. P.} = \frac{150 \times 0.2 \times \frac{1}{2}\pi d \times w \times N}{33{,}000} = .000238\, d\, w\, N.$$

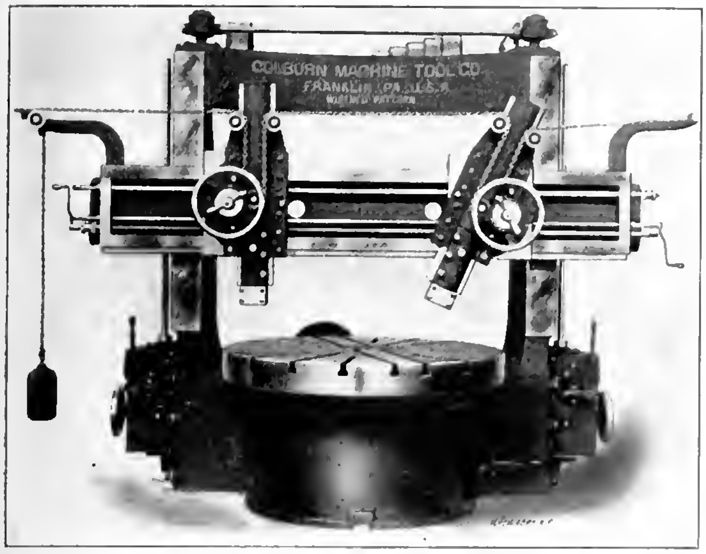
The uncertain quantities in the above formula are the pressure allowed at the points of contact of the two pulleys, and the coefficient of friction. The values used are based on the following considerations: The coefficient of friction was found to be constant, nearly, for all pressures of contact up to a limit which lies between 150 and 200 pounds per inch width of wheel face, beyond which limit its value apparently decreases. It also varies with the diameter of wheel. Paper wheels of 8, 12 and 16 inches diameter gave nearly the same coefficient, but one of 6 inches showed a 10 per cent decrease in the coefficient. The formula as given, therefore, does not apply to pulleys less than 8 inches in diameter. The coefficient is not affected by variations in peripheral speeds between 400 and 2,800 feet per minute. It shows the greatest increase with the per cent increase in the slip between the friction surfaces. A slip of 1 per cent. gave a coefficient of 0.14; a slip of 2 per cent. a coefficient of 0.2; and a slight rise above 2 per cent slip gave a rapid rise of the coefficient to 0.3, after which with an increase of the slip above 3 per cent the coefficient of friction drops rapidly and the wheels are unable to carry the load. From the foregoing, therefore, it is evident that pressures should not go beyond 200 pounds per inch width of face, and that the load should not be great enough to increase the slip beyond 3 per cent at the outside. The coefficient of friction of 0.2 can be used for leather in lieu of any better value as well as for paper. It is generally assumed in the transmission of power by leather belting that the coefficient lies between 0.25 and 0.3, so that 0.2 is evidently a safe value.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

THE COLBURN WIDENED BORING MILL.

The accompanying half-tone shows the 72-inch boring mill brought out by the Colburn Machine Tool Co., Franklin, Pa. They have applied the widening principle to this tool, so that by widening the bed casting and substituting a new cross rail and top brace the mill has an actual swing of 74 inches. Apart from these changes, and cone pulleys with wider faces for a 4-inch belt, this mill is built entirely like their regular 60-inch pattern. The tool is particularly useful for shops occasionally having large pieces to turn and bore out but not enough work to warrant the purchase of a heavy type 72-inch mill, also for work of large diameter but comparatively light or medium character. It is heavy enough for the use of high-speed steels on all cast-iron work but not for rapid turning on such work as locomotive steel tires.



Colburn Widened Boring Mill.

There are 10 changes of speed for the main spindle, arranged in geometrical progression. The main driving mechanism is contained in a separate headstock placed between the housings at the rear. This headstock can be removed, should it be necessary to take the machine apart. The main drive on the table is by spur gear and pinion.

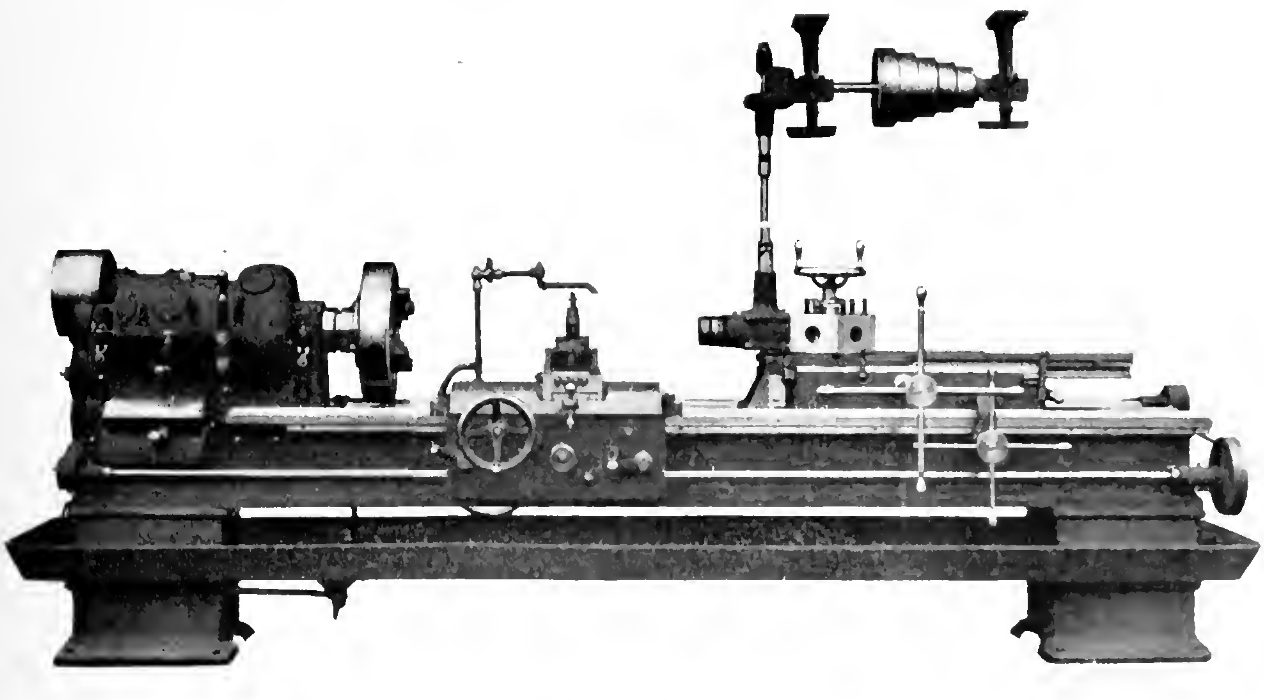
The heads are entirely independent in their movements and can be set to any angle. There are 10 positive feeds for each head, ranging from .025 to .500 inch horizontally and from .020 to .400 inch vertically. The feed boxes on each side are conveniently located for the operator. Turning the handwheel one revolution gives five changes of speed, and a multiplying lever in front changes the gear ratio, so that five more changes can be had by turning the handwheel a second time.

The hand lever near the top of the feed box is for reversing the feed or stopping it. All these feed changes are secured without stopping the machine. A friction brake, operated by a foot treadle within easy reach, eliminates all shock and jar and will stop the table instantly in any desired position.

A thread-cutting attachment, which can be applied at any time to the right or left-hand head, is supplied with this mill and will cut from 1 to 13, including 11½, threads per inch The principal dimensions are: Swing, 74 inches; maximum distance under cross rail, 47 inches; table diameter, 58 inches; travel of rams, 26 inches; length of cross rail, 9 feet 6 inches, floor space required, 12 feet by 7 feet 10 inches; weight, 22,500 pounds.

AMERICAN TWENTY-TWO-INCH LATHE.

The illustration herewith shows a 22-inch "American" lathe with patent all-geared head, turret, oil pump, pan and special boring device. The entire screw-cutting mechanism has been omitted on this machine, inasmuch as the lathe is primarily intended for roughing and boring; and the feeding mechanism, while of the same principle as that on the regular "American" lathes, is of a special nature. There are seven carriage feeds, ranging from .2 to .015.



American Tool Works Company's Twenty-two-inch Lathe

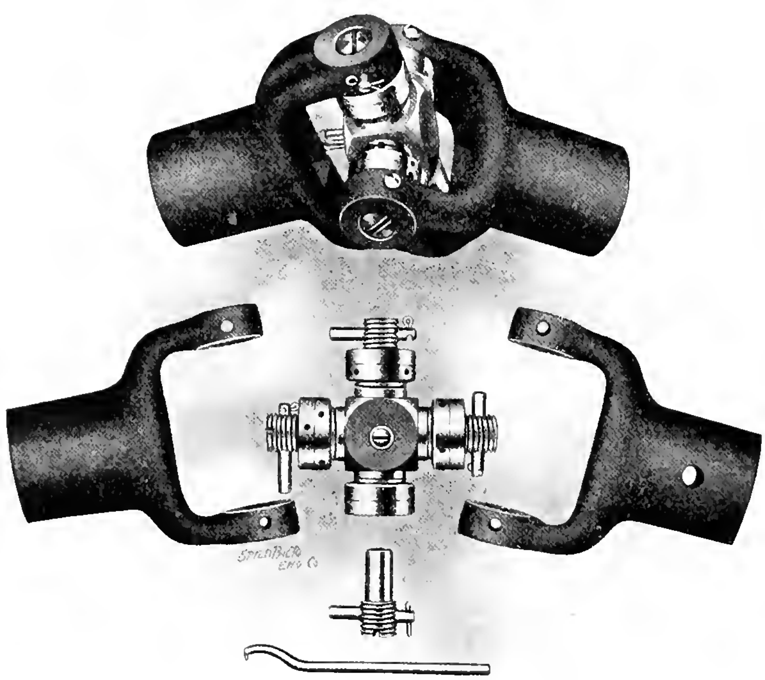
The geared head is simple, powerful and efficient. Only six gears are required to obtain four speeds through the levers shown on the front. The four speeds obtainable through the head, in connection with a triple friction countershaft, supply twelve distinct speeds to the spindle, ranging from 5 to 322 revolutions per minute.

The carriage is fitted with a plain block rest, which is provided with a calipering attachment, consisting of a set

of four adjusting screws, attached to the plain block rest after the manner of eyebolts, each one falling, when desired, over into corresponding slots in the yoke piece over the front carriage dovetail. By adjusting knurled locknuts on any of the four screws and dropping same into the slot, the travel of the cutting tool toward the center, and hence the diameter to be turned, is limited at pleasure. This attachment is very useful in duplicate work, as adjustments can be made for duplicate turning of pieces with four shoulders.

The hexagon automatic turret is of good size, with rapid and easy adjustments. It is provided with power feed, driven by sprocket chain from the feed rod, thus giving fourteen feeds to the turret, ranging from .16 to .007. The worm is dropped out of mesh with the wheel by an improved tripping device. The turret slide has an extra long bearing on the bed; the top slide has a 24-inch movement, controlled by pilot wheel, and is supported on the front end by an improved supporting shoe, which slides on the ways and is firmly bolted to the end of the turret slide directly under the cutting tool. It insures accurate alignment in boring, and has a gibbed bearing both at the top and bottom of the ways, thus preventing all spring in any direction.

The drilling attachment is affixed to one of the faces of the turret, and is very useful in boring operations. It consists of a symmetrical housing carrying miter gears, and



Baush-Bocorselski Universal Joint.

these actuate a spindle with ball-bearing thrust, which carries the boring bar. The spindle revolves from a separate overhead countershaft, as shown, by means of universal joints connected by a telescopic rod, which thus compensates for any movement of the turret slide. The boring spindle revolves in the opposite direction to the main spindle on the head, and has five rates of speed through the cone pulley on the countershaft. If it is desired to use another face of the turret, it may be revolved without disturbing the drilling attachment, owing to the telescopic rod.

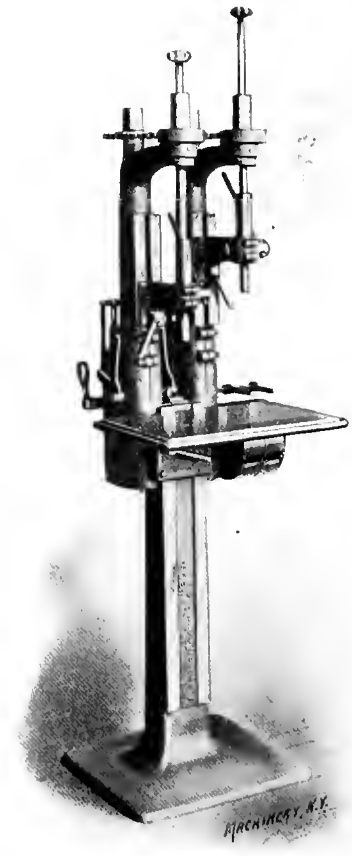
The boring tool is provided with an oil supply which is drawn up by an auxiliary pump through the turret stem and boring bar. The carriage has an oil supply similar to that of the turning tool.

The lathe is very substantial throughout, to adapt it to the very heavy strains which a lathe of this character must undergo. It is built by the American Tool Works Co., Cincinnati, O.

BAUSH-BOCORSELSKI UNIVERSAL JOINT.

The cut herewith represents a new universal joint designed by Frank E. Bocorselski and manufactured by the Baush Machine Tool Co., Springfield, Mass. The joint assembled is shown at the top of the view, in a position of about 15 degrees. It can be run at an angle of 30 degrees. The forks of the joint, shown on the right and left-hand side have a tapped hole to receive a trunnion screw (also shown) with a taper pin passing through it to keep the screw from turning in its fork section. Both the forks and the trunnion screws are of steel.

A novel feature of this joint is the transmission spool or block, shown in the center of the cut. This is of bronze and is bored through from end to end of the projecting arms, to receive the trunnion screw previously mentioned. This also leaves an oil reservoir in the center of the transmission block. The projecting arms have slots in them into which felt is inserted to distribute the oil from the reservoir along the bearing on the trunnion screw and the inner faces of the fork sections. There are two check nuts on each arm, for adjusting the joint to a central position and taking up wear. All the bearing surfaces are steel against bronze. The spanner wrench shown at the bottom of the cut is furnished with each set of joints.



Fenn-Sadler Two-spindle Sensitive Drill.

FENN-SADLER TWO-SPINDLE SENSITIVE DRILL.

The half-tone herewith shows a two-spindle drill press recently brought out by the Fenn-Sadler Mche. Co., Hartford, Conn. This machine was designed especially for manufacturing purposes, although it is handy for tool room work, being very quickly adjusted. The top columns can be swung to different positions, making a very handy feature for jig work, as it is possible to drill two holes without moving the jig and both holes can be drilled at the same time.

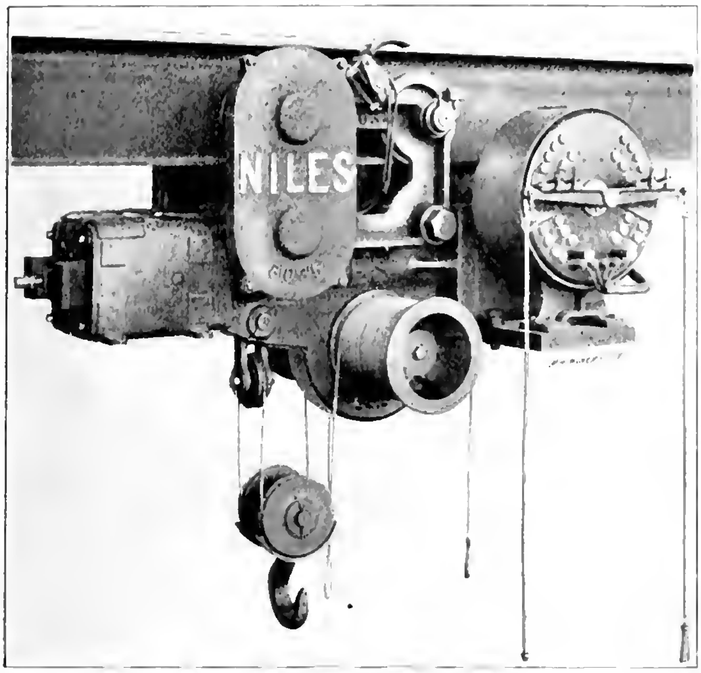
Both spindles have three changes of speed, each one independent of the other. The speed is changed by means of a lever which is operated from the front of the machine. The change of speed is obtained by sliding gears.

The machine is driven by gears. It has but the one belt and is very strong. It is warranted to drill ½-inch holes at the speed that manufacturers desire at the present day.

NILES ELECTRIC TRAVELING HOIST.

The half-tone (next page) shows a new type of hoist built by the Niles-Bement-Pond Co., New York. It is built in capacities of ¾ to 6 tons, and may be used either as a hoist, running on an I-beam track, or for a small capacity crane in which case it is mounted on a traveling bridge. In the latter case it is

arranged to run between two I-beams, or channels, of the bridge, and the controllers for raising or lowering the hook and operating the traversing mechanism may be placed either on the hoist, on the bridge and operated by cords from the floor, or from an operator's cage attached to the bridge. When used on an I-beam the controllers are attached to the hoist and operated by cords from the floor. The hoist will run on straight or curved tracks, and is usually provided with a separate motor for traversing, but if desired hand



Niles Electric Traveling Hoist.

traverse may be furnished, or all the traversing mechanism may be omitted and the trolley moved along the track by pushing on the load. The increased service of the electric traverse, however, more than compensates for the slight additional cost.

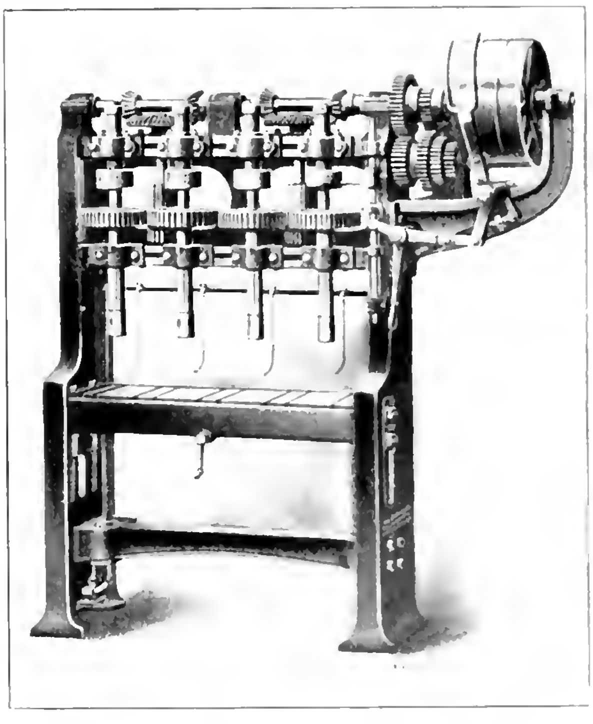
The hoist is self-contained in one heavy cast-iron frame, to which the motors are attached end on, and the power is transmitted directly from the armature shaft to the drum shaft through a train of worm and wheel gears. The traversing mechanism is also driven by worm and wormwheel gears, except that when the trolley is arranged to run on a single I-beam a double set of gears is used to connect the worm gear shaft to the truck wheel shafts. All the mechanism is enclosed in oil- and dust-proof casings. A powerful electric brake is attached to the hoist motor.

NUT TAPPER.

While practically all nuts are tapped by running through them a tap with a long shank on which the nuts are collected, there are a large number of articles which cannot be tapped by this method, since it is necessary in many instances to back out the tap. Any piece which is to be threaded with a taper hole (and this includes nearly all pipe fittings) must have the tap backed out. Also, articles which do not have a hole clear through them must be threaded by first running in the tap and then backing it out. Still other pieces, which are to be tapped only to a certain depth must be threaded by the same process. It is apparent that if a tap is to be reversed it must be provided with a leadscrew of the same pitch as the tap, in order that the tap may not grind around in the hole after it has just cleared the threads. Furthermore, when a positive feed in the shape of a leadscrew is used some kind of a relief is necessary which will yield in case the tap misses the hole and strikes solid metal, as otherwise the machine might be wrecked. Adjustments should be provided for varying the speed, the distance which the taps will move, for cutting threads of different pitches, for running right or left-hand; and means must be provided for quickly and automatically reversing the taps at any desired position.

The National Mchy. Co., Tiffin, O., have brought out a tapper in which the attempt has been made to meet these various requirements. The half-tone shows the general design. Three pulleys—a driving pulley, a reversing pulley and an idler pulley—are carried on the horizontal shaft at the top. Next to the pulleys is a cone of gears by means of which the speed of the tapping spindles may be easily regulated. Below the pulleys and carried on the overhanging arm are a set of levers, by which the machine is automatically reversed at any desired position and then brought to rest with taps in their highest position. Each tap spindle is equipped with a relief device which can be so adjusted that any pressure on the tap—within reasonable limits—will cause it to yield. In addition each spindle carries a sleeve leadscrew, which can be easily removed and replaced by one to suit the pitch of the tap. The tap spindles are made to revolve for either right-hand or left-hand threads, by throwing in either one or the other of the bevel pinions on the top of the machine.

The table is machined on top, and is equipped with T-slots for clamping the jigs which hold the work. It is provided with means for easily adjusting its height. A system of force lubrication is used which not only oils and cools the tap, but also carries away the chips into the movable chip pan. The operation of this tapper is as follows: When the machine is at rest and the taps are in their highest position, the work is secured in the jigs, located on the table; the hand lever is then to the left shifted, throwing the belt on the driving pulley and starting the machine in motion. The taps rotate and descend at the same time, tapping the work, until a definite position is reached at which point they automatically reverse and back out of the holes which they have just threaded; as soon as they reach their highest position, the belt is automatically thrown onto the idler pulley and the machine comes to rest. New work is then secured in the jigs and the operation is repeated.



Four-spindle Nut Tapper

The machine illustrated occupies a floor space of 6 feet 5 inches by 3 feet 3 inches and has a net weight of 3,000 pounds. The manufacturers are prepared to build jigs for holding any class of work which it is desired to tap on this machine.

ELECTRIC HOIST.

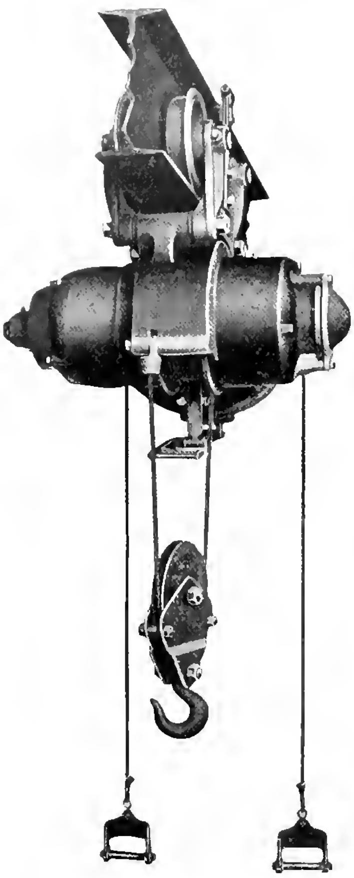
The General Pneumatic Tool Co., Montour Falls, N. Y., have placed on the market an electric hoist known as the Shepard hoist. This apparatus has a number of new features which can be best referred to by taking up the different parts in order.

The motor is fully inclosed but the commutator and brushes are easily accessible and are visible through mica windows.

Two carbon brushes are employed and flexible metallic leads are used to carry the current, to avoid sliding contacts. The armature and field windings may be removed without disturbing other parts of the hoist.

The controller is inclosed in a separate case, independent of the hoist proper, and is arranged for a wide speed control. The segments, while fully protected, are visible at all times. Each contact has an independent magnetic blow-out. The controller is reversible and gives equal speed control in hoisting and lowering. While it is ordinarily mounted on the hoist it may be located elsewhere if desired.

An automatic stop is provided to prevent overwinding. It acts directly on the lower block, and cannot be put out of adjustment by the stretching of the cable. A mechanical brake is provided, to prevent the load from running down when the motor is at rest. It offers no resistance to hoisting but can only be released by reversing the motor and it can be immediately set again should the load descend at a speed slightly greater than that corresponding to the speed of the motor. No current is consumed in loading, aside from the small amount necessary to rotate the motor under no load. The friction surfaces of the brake are submerged in oil. An electrical brake is also applied directly to the armature shaft and is always set at full power unless held off by the current flowing through the armature. The gear consists of a double train of machine-cut and spur gears contained in a sealed case and submerged in oil. This part of the apparatus has been designed like the other parts, so that the gears can be removed without interfering with any other section. Replacing the cover secures the gearing ready for service, and there are no pins, keys or screws to be replaced.

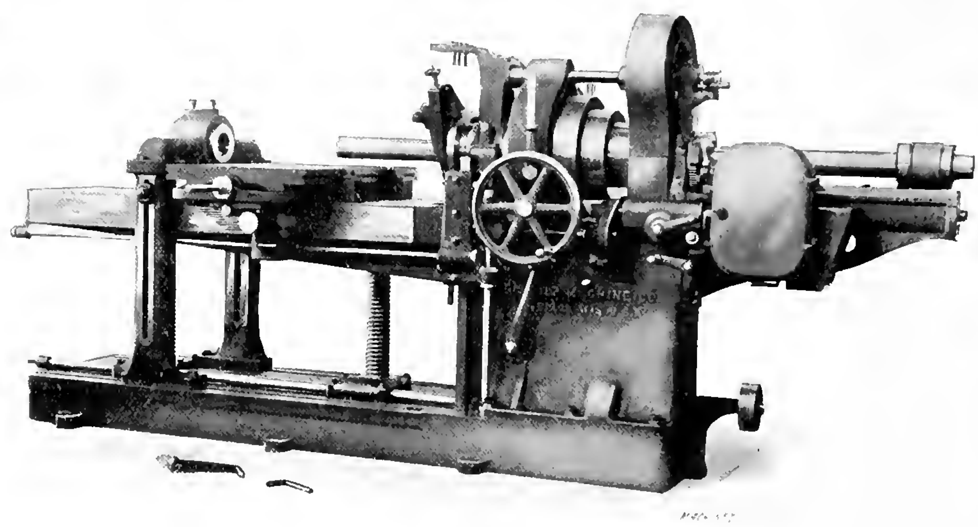


Electric Hoist.

The trolley is made in a variety of forms, one of which is shown in the illustration. It is provided with roller-bearing wheels, having chilled spherical treads, and will be furnished with pendant hand chains or an electric motor, for the traveling movement, if desired. It requires unusually small head room. It is claimed for this hoist that it consumes less power than the worm-driven hoist; that the brakes hold the load positively, without absorbing power while the hoist is operating; and that the accessibility of the various parts, and the wide speed variation, are strong points in its favor.

HORIZONTAL BORING MACHINE.

The horizontal boring machine shown herewith is one of the latest tools produced by the Gisholt Machine Company, Madison, Wis. The headstock is of the friction back-geared type with two sets of back gearing. The boring bar is of hammered crucible steel accurately ground and with taper socket for the insertion of supplementary boring bars. The feed mechanism is of the same type used on the Gisholt lathes, namely, by means of a coarse-pitch screw. The feed is positive and no extra attachment is required for screw cutting. Operating levers are located on both sides of the machine, thus giving absolute control from either side. The table adjustment is a new feature. By the simple movement of one lever convenient to the operator when standing close to his work, the table may be accurately raised or lowered by power and is capable of the finest adjustment. The cross table has a compound movement and is fitted with a power cross feed when desired. Both transverse and longitudinal screws for moving the cross table are fitted with micrometer index dials reading to .0010 inch. The yoke for the table is of the box section form of a very rigid construction and is clamped in the table instead of by use of bolts in T-slots. It carries double bushings for support of the boring bar. This machine is one of several shown by this company at St. Louis.



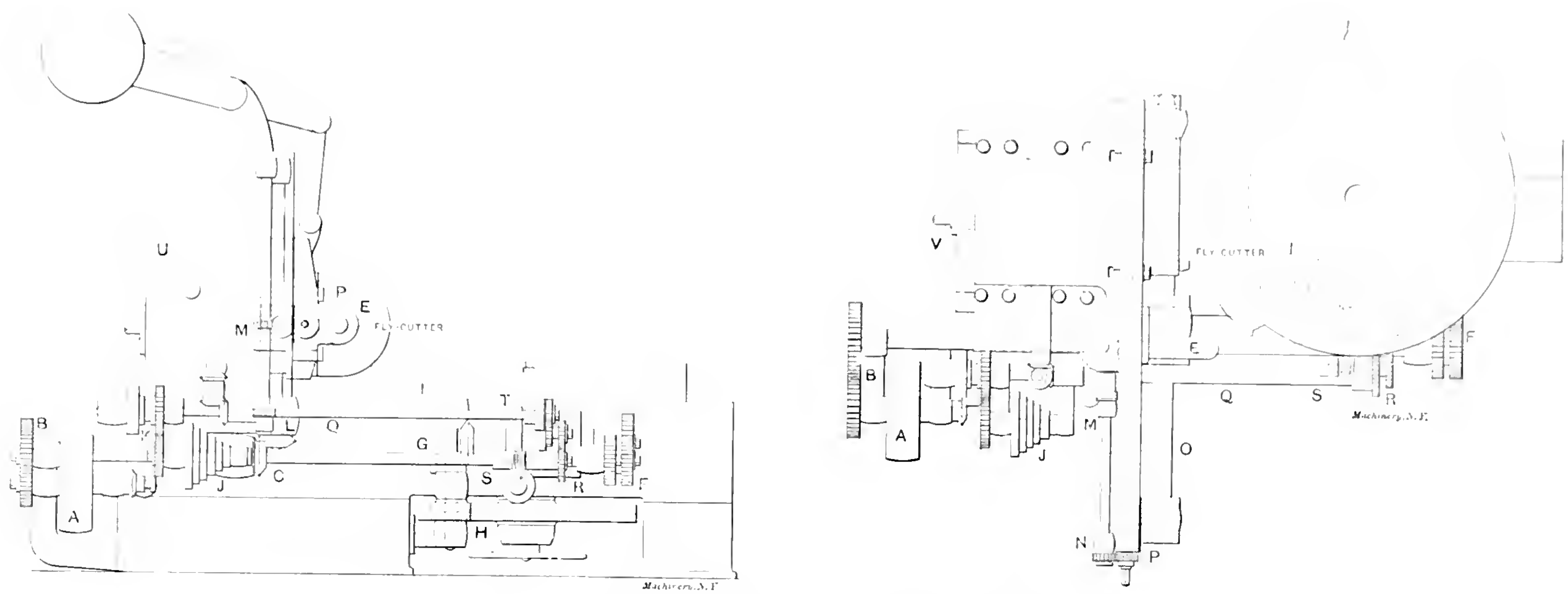
Gisholt Horizontal Boring Machine.

WORMWHEEL GENERATING MACHINE.

The increased demand for a machine to generate accurate wormwheels has led to the design shown herewith. As will be seen, the design is especially rigid; the stiff anvil construction allows of taking very heavy work and heavy cutting without the usual bad strains. The machine is constructed to generate wormwheels either with or without the use of a hob. Although there have been similar machines built for this purpose in Europe, and one in the United States, at the works of Hugo Bilgram, this machine embodies many distinct and original improvements.

The cutter drive and dividing train is driven by the pulley, *A*, thence through the speed-change gears, *B*. The bevel gears, *C*, and worm and wormwheel, *E*, connect with the tool. The horizontal shaft extends to the dividing change-gears, *F*, through the "jack-in-the-box" and gears, *G* and *H*, to the work spindle. The faceplate gears, *I*, are used for driving very heavy work of large diameter, to eliminate all torsion of the work spindle.

The feed-drive and conjugating train are driven from the cone, *J*, thence through the change gears, *K*, worm and wormwheels, *L* and *M*, gears, *N*, to the feedscrew *O*, which gives the slide, *P*, and cutter-spindle the movement or feed tangential to the blank. The shaft, *Q*, connects with the gears, *R*, worm and wormwheels, *S* and *T*, and the "jack-in-the-box," which gives a plus or minus amount to the rotation of the blank. The use of the "jack-in-the-box," or differential gearing, is a very convenient method for giving the blank the same amount of movement along the pitch line, as the tool passes through in feeding endwise, in cutting with the single tool or a taper hob. The two movements, the dividing movement and the conjugating movement, are thus combined, so as to give the blank the effect of both. The conjugating movement alone would give the blank one correct spur notch, gen-



Elevation and Plan of Eberhardt Brothers Company Wormwheel Generating Machine.

erated by the tool. The dividing movement gives the blank the necessary wormwheel rotation, or indexing. Combining these movements through the "jack-in-the-box," the blank is continuously rotated, and at the same time receives the tangential conjugations, so that the result is to produce a perfect generated wormwheel.

In the earlier machines which used the single tool or taper-hob principle, the cutter spindle was supported by a slide underneath it which gave it the required endwise movement or feed. That method of construction required the cutter spindle to be made in a large span between its bearings, and also placed the cutter spindle several inches out from the frame of the machine. In the machine illustrated, the cutter spindle is supported by stationary bearings, and is moved endwise by means of a slide at one end of the spindle. This gives greater rigidity to the cutter spindle, by bringing the bearings closer together, and thus shortening the span of the spindle and placing the spindle close up to the frame.

This machine can accommodate the ordinary cylindrical hob, in which case the tangential feed is stopped by locking the tool slide, *P*. The stanchion, *U*, is then fed forward by means of the screw, *V*, and the hob enters the blank in the usual hobbing manner. The single or fly cutter method is used either to save the expense of a hob, as where only a few wheels of a certain pitch are to be made, or in a case where a particularly accurate gear is required. The fly cutter is the cheapest and yet the most accurate tool for wormwheel generating. It is ground after hardening, thus eliminating the imperfections that develop in hardening hobs. It is simple to make, being merely the shape of a single rack tooth. The standard thread angle $14\frac{1}{2}$ degrees, may be used, but this may be varied to suit special requirements. For instance, where a wheel has a small number of teeth, the angle may be made 20 degrees to avoid under-cutting.

In operation the cutter-spindle is set to the correct center distance by means of a vernier scale on the bed and stanchion. The tool is set out the proper distance from the spindle center (one half the outside diameter of the worm, plus the clearance) and is swiveled to suit the worm thread angle. The tool commences cutting at one side of the blank, and the cutter spindle feeds endwise, tangent to the blank, until the wheel is finished. For commercial purposes, one passing across is sufficient to finish the wheel, but much better results are produced by taking a finishing cut. This method of cutting is not a "nibbling" process; on the contrary, the chips are heavy, and resemble planer chips.

In cutting wormwheels with a fly cutter, it may be valuable to note that considerable time can often be saved by having a "hunting tooth." To illustrate: In cutting a wormwheel of 10 teeth, in which the ratio of wheel to worm is 1 to 1 (a ratio which this machine can easily cut) the wheel would have to be indexed 9 times; whereas, if the wheel could have 11 teeth, to suit a worm of 10 threads, one setting of the fly-cutter would cut the 11 teeth without any further indexing.

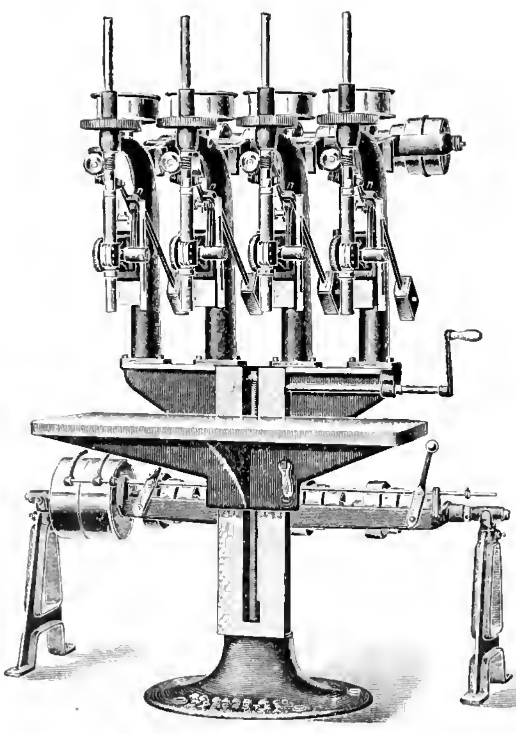
This machine accommodates single or multiple thread worms of any diameter. Right- or left-hand threads are cut by merely setting the tool to the right or left. It is made in two styles: The plain style cuts wormwheels in which the worm is at right angles to the axis of the wormwheel. This style cuts spur gears with the ordinary rotary cutter. The universal style cuts wormwheels to suit worms at any angle to the wheel axis. This style also cuts spiral and spur gears either with the ordinary rotary cutter or with a hob. Six sizes of each style are built, by Eberhardt Brothers Machine Company, of Newark, N. J.

SENSITIVE DRILLING MACHINES.

The use of high-speed drills, together with the modern practice of duplicate jig work, has created a demand for more

powerful machines of the class known as sensitive drilling machines. To meet this demand H. G. Barr, Worcester, Mass., has brought out ten new machines. One of these styles has two, three, four, five and six spindles guaranteed to drill up to ⅝-inch holes in ordinary practice, but not intended for high-speed drills of that size. These have one-inch spindles with ball-bearing thrust collars, the bearings being made of tool steel from the bar. There is a No. 2 Morse taper in the spindles, and three speeds independent to each spindle. The spindles have a traverse of 5 inches. The heads are adjustable and the tables are also adjustable on the columns. The spindles have power feed driven independently from each spindle, also automatic stop and quick return. All the drills have lever feed and power feed, but are furnished without feed, at lower cost, if desired.

Another style is built in five sizes with two, three, four, five and six spindles. It is similar to that described above with the following additional features: The spindle driving pulleys are set on studs back of the spindles and are geared to the spindles with spur gears about 2 to 1, giving sufficient power to drill ¾-inch holes easily with high-speed drills. They will drill holes larger than this but are not warranted to stand continuous use with ⅞-inch drills, or larger, as these sizes are for a heavier class of machines. The tight and loose pulleys on all these machines are 10 inches by 3¾ inches. The manufacturer states that these machines are strong and durable and have been designed with a view to adapting them to up-to-date needs and, added to their regular line, make a very complete line of sensitive drilling machines, there being 36 different machines.



Barr Sensitive Drill.

GRIDLEY AUTOMATIC TURRET LATHE.

The Windsor Machine Co., Windsor, Vt., have for some time been manufacturing an automatic turret machine for bar work that is a distinct departure from other automatic screw machines. They have brought out a machine of entirely new design, embodying the more important features of the earlier machines, but containing a new arrangement of mechanism and tools. In this, as in earlier machines, the tools are fastened to and supported by slides gibbed onto the periphery of the turret which does not move axially, but is mounted to revolve on an axis parallel with the spindle.

In the base of the machine is the horizontal cam shaft containing the drums and disks to which the cam plates or dogs are fastened for actuating the various motions of the machine.

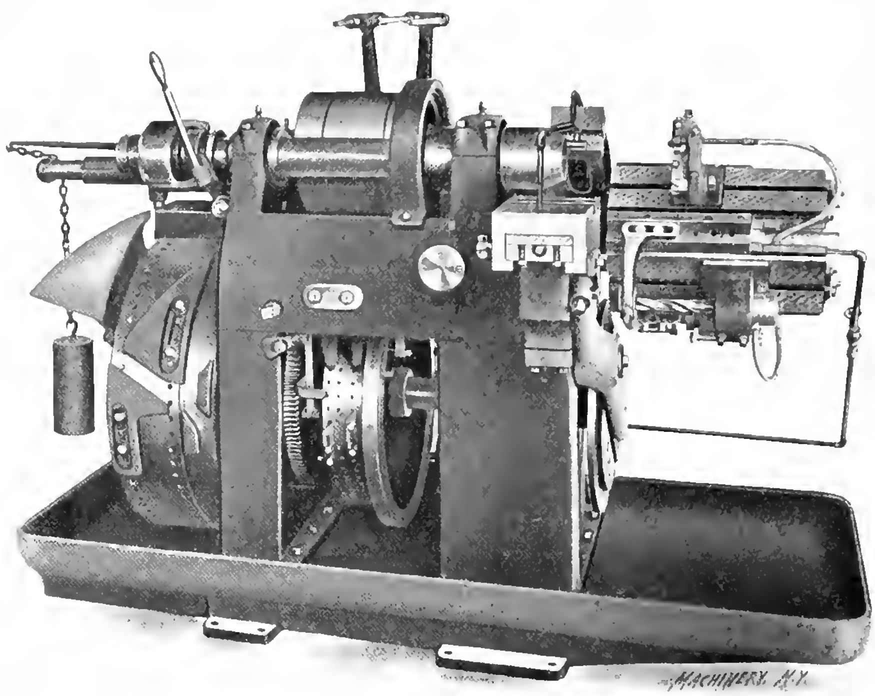


Fig. 1. New Automatic Turret Lathe.

The turret is supported by a hollow spindle running in bearings at each end of the headstock. On this spindle is keyed a wormwheel and an index plate, the latter having four notches corresponding with the four slides of the turret. The wormwheel is driven by a worm on a shaft at right angles to the lathe spindle, and on the rear end of which is the belt pulley which runs continuously. The worm is thrown into or out of action by a clutch mechanism operated by a lever which receives its motion from the drum at the center of the cam shaft. This lever also withdraws a locking pin which fits into the notches in the index plate. The arrangement of the mechanism is such that the pin must be positively withdrawn before the clutch faces come in contact, and also the clutches must be thrown out of contact before the pin can again engage the notches.

The turret slides derive their feed from the large cam plates bolted on the face of the cam wheel at the left of the machine. These plates operate a drew bar extending through the hollow spindle of the turret and engaging a pin attached to the under side of each slide when the slide is brought into position by the rotation of the turret.

The lathe spindle is fitted with a draw chuck operated by cams on the right of the large drum. Inside the sleeve of the draw chuck is a feed tube for feeding the stock through the spindle. This is split at the chuck end of the spindle so as to grip the stock securely enough to feed it forward, but slide over the stock when the chuck is closed on it and the sleeve is drawn backward by the large cam attached to the left-hand side of the large drum. This places the sleeve in position for feeding the stock again under the action of the weight shown in the engraving, after the usual method in such machines.

The cams attached to the face and left-hand side of the small drum at the center of the machine are for shifting the spindle and feed belts. The spindle is back-geared at a ratio of 4 to 1, and is driven by either of two belts—one of which reverses the motion of the spindle when backing out a tap. If automatic dies are provided, however, both belts may run in the same direction, thus making two belt speeds. The disk at the extreme right of the cam shaft carries two sets of cams, one for the cut-off arm and the other for moving the forming

slides, plainly shown in the illustration. Perhaps the chief interest in the machine centers about the novelty of the horizontal turret with its slides, to which are bolted the tools and tool holders. This arrangement enables a great variety of work to be done with comparatively simple tools which are readily adjusted. Much of the work is performed by single-point cutting tools or turners instead of with box tools or forming tools. The turret slides have longitudinal T slots so that the tool holders may be located at any point in the length of

Fig. 2. Turner used on Lathe.

the slide, which fixes their position relatively to the work, while the feed cams determine the time and extent of the movement of the tools.

The half-tone, Fig. 2, shows one of the turners regularly supplied with the machine, which is to be clamped directly to ono of the turret slides. This turner carries its own back rest and uses a single-point cutting tool. The back rests shown in place are of the usual type consisting of blocks clamped in position, but roller back rests, such as shown standing beside the turner in the engraving, have been found to give very satisfactory results and to greatly reduce the friction.

In Fig. 3 are details of a cross slide designed to be clamped to one of the turret slides and to be used in turning, by the aid of a former bolted to the turret. This is designed so that the slide carrying the tool withdraws automatically on the return,

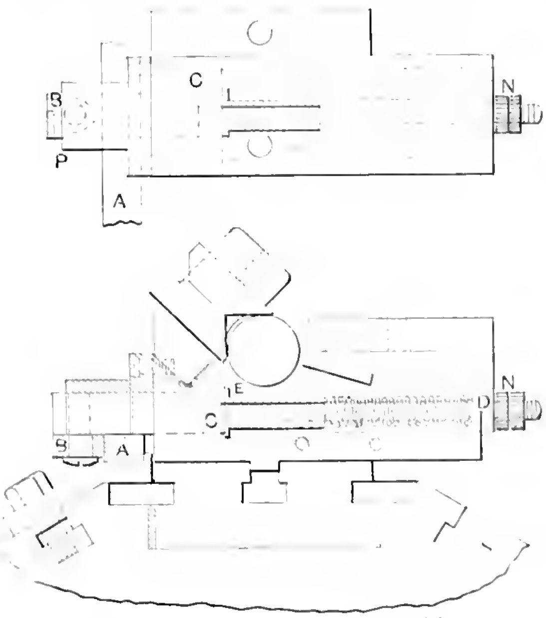


Fig. 3. Tool Slide and Back Rest.

thus preventing the cutting edge from rubbing over the finished work. In the illustration *A* is a guide against which the swivel block *D* pivoted to piece, *C*, bears. Piece *C* extends through the head and is threaded on the end for the nut, *N*. The spring bearing against the slide at *D* and against the bushing at *E*, which at its other end bears against the casting supporting the back rest, tends to continually push the tool away from the work as far as allowed by the position of the nut, *N*, thus taking up all backlash. When the tool begins to cut, the swivel block *B* takes the position shown in the upper view, with the pin, *P*, bearing against one side of the slot. When the tool travels in the other direction, the block swivels slightly until the pin bears against the other side of the slot and allows the spring to force the tool a slight distance away from the surface of the work. Fig. 1 shows a similar device arranged for a fixture containing a boring, turning, and facing tool, and designed primarily for taper work, although the

Fig. 4. Taper Turner

piece shown at *A* is cylindrical. *B* is the former pivoted at *C* to a block attached to the turret. In case taper work were to be done, the outer edge—the upper edge in the engraving—would be the taper surface of the former against which the projecting piece attached to the slide would bear. Against the back or lower side of the former a swivel block, *D*, bears, which is pivoted to the base of the attachment. The purpose of this block is to relieve the tool on the return as in the turner shown in Fig. 3, without in any way affecting the adjustment of the guide bearing against the taper part of the former, which determines the shape of the piece.

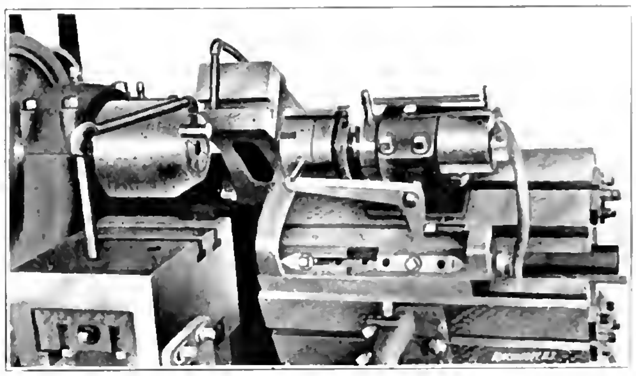


Fig. 5. Geometric Die Fitted to Lathe

The illustration, Fig. 5, and the line drawing, Fig. 6, shows the way in which a geometric self opening die is fitted up for use on the machine. As the die advances upon the work lever *B* comes in contact with the stop, as indicated, and opens the die. Upon the return the arm, *C*, of the bell crank lever hits a stop bolted to the lathe turret which throws up the long arm of the lever, hitting pin *A* of the die and closing it.

In Fig. 7 is the drilling attachment, fitted up with a hollow drill. The guide bushing for the drill is carried by an arm

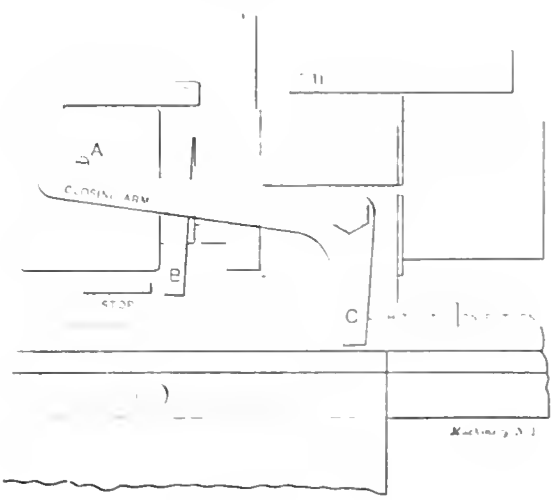


Fig. 6. Details of Die Holder

bolted to the turret while the drill holder is clamped to one of the turret slides. Oil is carried to the drill by flexible tubing, and the arrangement is such that oil is supplied to this and to the other tools only when the slide carrying each tool

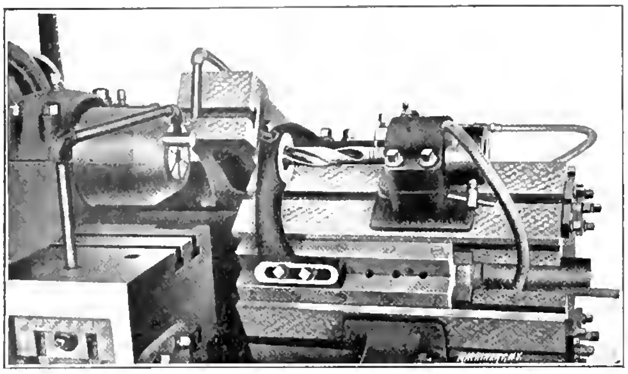
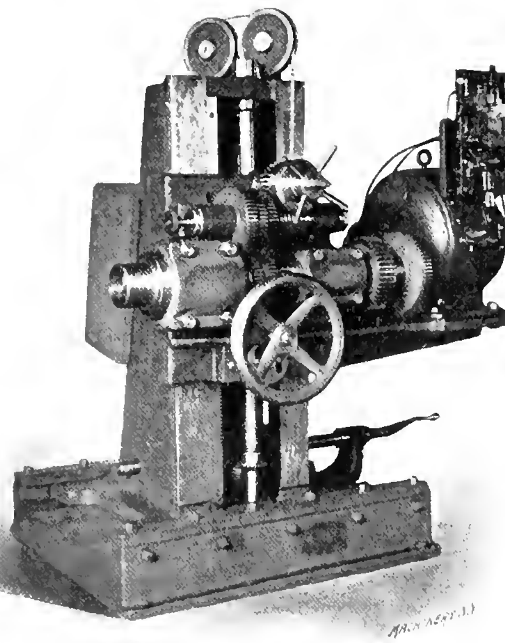


Fig. 7. Drilling Device, Gridley Automatic Turret Lathe.

is in a position where oil is required. In every other position the slide automatically shuts off the supply, so that the oil is not flowing over parts of the machine where it is not desired.

SARGENT MILLING MACHINE.

A special milling machine made by W. L. Sargent, Fitchburg, Mass., is shown in the accompanying illustration. The frame consists of a heavy upright made to travel in ways on the base of the machine. The saddle carrying the working spindle travels vertically on the column and is balanced by a casting supported by a cable at the rear of the column. The machine is driven by an electric motor located on the saddle, so that the machine is self-contained and independent of



Sargent Special Milling Machine.

belts and pulleys. It has power feed in a vertical direction. The feed is driven through a cone of gears and a friction clutch. The principal dimensions of the machine are: Vertical movement of saddle, 20 inches; hole in spindle No. 6 Morse taper. Saddle has power down feed with three changes. Spindle driven by constant speed two H. P. motor, arranged to give suitable speeds by change of pinions. Front spindle bearing $4\frac{1}{2}$ by 8 inches. Size of base 33 by 38 inches. Net weight of machine with motor, 4,200 pounds.

* * *

Some brands of high speed steel are very high in price, but perhaps their cost to the user is not disproportionate to their cost to the maker when we consider the high price of many of the constituents used. For instance, vanadium costs, abroad, about $10 per pound; molybdenum, $1.50; tungsten, 65 cents, and nickel, 35 cents.

FRESH FROM THE PRESS.

MECHANICAL APPLIANCES AND NOVELTIES OF CONSTRUCTION. By Gardner D. Hiscox. Published by the Norman W. Henley Publishing Co., 132 Nassau Street, New York. 396 8vo. pages. Illustrated with nearly 1,000 engravings. Price $3.00.

This is a supplementary volume to the one upon mechanical movements by the same author, which has passed through ten editions. Instead of dealing with elementary movements like the earlier volume, it contains illustrations and short descriptions of many combinations of motions and of mechanical devices and appliances found in different lines of machinery. Some of the chapter headings are: Steam Power Appliances; Hydraulic Power Appliances; Road and Vehical Devices; Horological Time Devices; Textile and Manufacturing Devices; Perpetual Motion; etc. While perpetual motion, of course, is a dream and a fallacy, the historical treatment of the subject in this chapter will prove of interest. The other chapters, however, deal with practical devices. The engravings are all made by the wax process (the same that is employed in MACHINERY) and are unusually well executed. The book will appeal to mechanics, inventors and others who wish to familiarize themselves with interesting mechanical devices covering a wide range of work in many fields.

A SECTIONAL DRAWING OF A MODERN BATTLESHIP WITH REFERENCE LIST OF PARTS. Published by the Derry-Collard Co., New York. Price 50 cents.

This is probably the finest sectional engraving of a mechanical subject that has ever been produced. It shows a longitudinal section of a modern United States navy battleship of the *New Jersey* and *Connecticut* type, completely equipped and supplied with the stores necessary for a sea voyage. The section has been drawn in different planes at different points of the ship, so as to show the interior of all the important compartments into which the hull of a vessel is divided, regardless of whether they are located in the central plane of the boat or at front or back of it. By this means practically everything that goes to make up a battleship and its equipment is shown. There are in all 497 items to which reference is made in the list of parts.

The original drawing from which the engraving was produced is a wash drawing in black and white, the preparation of which extended over a period of two years. The reproduction is nearly 3 feet long, and $13\frac{1}{2}$ inches high. It is printed on heavy plate paper, suitable for framing. Reference to certain details will show the care with which every part has been gone into. Of the machinery equipment, besides the engines and boilers all the auxiliary machinery, such as winches, steering gear, blowers, pumps, etc., are shown and the machine shop and laundry are shown fully equipped, and we note that in the machine shop even the handles of the engine lathe are drawn, so carefully has the artist gone into details. We are informed, moreover, that all these parts are in the correct proportions, as the details represented were carefully measured before being placed on the drawing if their sizes were not known. The method of hoisting the ammunition is indicated, the food supply in the refrigerator is shown, as well as other stores, furniture, etc., etc. Underneath the drawing is a scale by which dimensions of any of the parts can easily be determined. The ships semaphore signals are set, the speed cone has been elevated, indicating "full speed ahead," and the flag signals read: "We can defend ourselves." The drawing was approved by naval officers before the engraving was made.

MANUFACTURERS' NOTES.

THE NEW ENGLAND ROLLER GRATE CO., Springfield, Mass., have decided to open up a store for the sale of machinery, new and secondhand, and shop and foundry supplies, at 218 Worthington St., on the first of December.

THE NORTHERN ELECTRICAL MFG. CO., Madison, Wis., were recently awarded the order of the Cutler Hammer Mfg. Co. for the electric equipment for their works, consisting of a 75 K. W. and a 37.5 K. W. generator

THE BLANCHARD MCHE. CO., Boston, Mass., report that on Nov. 11 their office at No. 11 Harcourt Street, was burned out, there being considerable damage. This, however, will give them an opportunity to secure larger quarters so long needed.

THE CROCKER-WHEELER CO., Ampere, N. J., are distributing a postal card stating that they are supplying the electric light and power plant for the U. S. S. *Connecticut*, which consists of 8 Crocker-Wheeler generators direct-connected to Forbes marine-type engines.

THE BAY STATE EMERY WHEEL CO., Worcester, Mass., have purchased the real and personal properties owned by the National Emery Wheel Co. and will continue the manufacture of corundum and emery wheels by the same processes, and under the supervision of Superintendent H. F. Sanderson.

HENRY E. EBERHARDT, who was identified with Gould & Eberhardt, Newark, N. J., for more than 35 years, as a member of the firm, chief designer and inventor, has resigned from the above company, and is now associated with his sons in the Eberhardt Bros. Machine Co., Newark, N. J

THE NORTHERN ELECTRICAL MFG. CO., Madison, Wis., are equipping the new plant of the 23d Regiment Armory, Brooklyn, with two 75 K. W. "Northern" generators direct-connected to a Harrisburg engine, and with a 35 K. W. "Northern" generator belted to a Nash gas engine.

J. G. BLOUNT CO., Everett, Mass., manufacturers of lathes and grinding machines, have just completed a new storehouse next to their shop, which will give them additional facilities for carrying a larger stock than they have heretofore been able to, so as to fill all orders for their tools on receipt.

THE VITRIFIED WHEEL CO., Westfield, Mass., have recently moved into their new plant. The plant is well lighted and built after approved modern methods. This company manufacture pure corundum wheels for grinding purposes; also vitrified wheels, made of a new crystal corundum.

The McCullough-Dalzell Crucible Co., Pittsburg, Pa., have just completed a new dry house, comprising a series of deep pits, flanked by large furnaces. The drying process is an important factor in crucible making. Natural gas is the fuel used for heat and power. The company report an encouraging growth of new business during the year.

THE BURKE ELECTRIC CO., Erie, Pa., is a new company incorporated under the laws of New Jersey with a capital of $150,000. They have absorbed the Keystone Electric Co. of Erie, Pa., whose plant they will occupy, and are to manufacture dynamos and motors under the patents of James Burke, president of the company. Herbert B. Coho is vice-president and Gustave Faure manager and superintendent.

We have received a letter from the Coes Wrench Co., Worcester, Mass., saying that they have recently been visited by four engineers from Vienna, Austria, who are securing information from American plants, and from conversation with them the Coes Wrench Co., is led to believe that they are attempting to secure points about the manufacture of American hardware, which will be detrimental to the interests of firms selling abroad, where the competition of foreign manufacturers of hardware is very keen.

The National Electric Co., Milwaukee, Wis., have entered into an important arrangement with Robert Lundell and Robert T. Lozier, by which the National Company will manufacture and market the new motors and generators and systems of operation and control that are covered by the latest inventions of Robert Lundell; the commercial direction of the undertaking being placed in the hands of Robert Lozier, who will also act as general manager of the Electrical Sales Department of the National Company. Mr. Lundell assumes the direct supervision of the engineering involved under the license that he grants the National Company, and which covers all of Mr. Lundell's inventions not already under license to other companies, and all inventions that he may hereafter make during the life of this license.

NEW TRADE LITERATURE.

Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes

James McCrea & Co., Washington St., Chicago, Ill. 1904 catalogue of steam specialties.

The Whitman & Barnes Mfg. Co., Chicago, Ill. Illustrated catalogue of haying tools and supplies.

Zeh & Hahnemann, 213-219 Chestnut St., Newark, N. J. Circular of this company's inclinable power presses.

The Western Electric Co., Chicago, Ill. Bulletin 6010 of knife switches. The various styles of these are here shown and described.

The Cook Mfg. Co., Albion, Mich. Catalogue of gas and gasoline engines. The Cook engine is here described and illustrated in detail.

The Dean-Waterman Co., Covington, Ky. Catalogue of the "Dean" gas and gasoline engines, built in sizes from 2 to 50 horse power.

The Crowe Metal Mfg. Co., Chicago, Ill. Illustrated catalogue of metal name plates.

The Henry Walke Co., Norfolk, Va. Catalogue H of portable sawmill machinery and similar specialties, as manufactured by the Curtis & Co. Mfg. Co.

The Emerson Electric Co., St. Louis, Mo. Bulletins Nos. 3060 and 3061 showing bipolar enclosed motors, and friction and bench drills driven by Emerson motors.

The Mechanical Appliance Co., Milwaukee, Wis. Booklet illustrating the "Watson" multipolar motors and generators and their application to various types of machinery.

The Wellman-Seaver-Morgan Co., Cleveland, Ohio. Pamphlet descriptive of the Akron Chilian mill designed and built for the wet grinding of metalliferous rock. This is described in detail.

Greene, Tweed & Co., 17 Murray St., New York. Illustrated catalogue of belt studs, belt couplings, piston and sheet packings, the "Rochester" automatic lubricators, wrenches, the "Colvin" interchangeable hammer, etc.

The Norton Emery Wheel Co., Worcester, Mass. Leaflet relative to India oil stones. These are regularly made in 34 shapes covering ordinary demands of the trade, but anything special in this line will be made to order.

The Gem Mfg. Co., Pittsburg, Pa. Illustrated catalogue of oilers, torches, flexible shafting, boiler-tube cleaners, loose-pulley lubricators, etc. Also circular of the Nos. 1 and 2 impulse water-tube boiler cleaners.

The Manhattan Electrical Supply Co., 32 Cortlandt St., New York. Circular of the Hubbell shade holder which, it is stated, is simple in design, strong, durable and holds the shade rigidly without chance of its loosening.

The Charles E. Wright Co., New Orange, N. J. Catalogues of saw machinery. Catalogue "A" takes up band and circular saws; another, wood and metal band sawing machinery and a third takes up cold metal cutting.

The Falls Rivet & Machine Co., Cuyahoga Falls, Ohio. Illustrated catalogue of the Wadsworth improved core machine, making 24 sizes of round cores from 3/8 to 6 inches; also, square, hexagon and irregular shapes.

The C. W. Hunt Co., West New Brighton, N. Y. Catalogues Nos. 046 and 047. The first treats of electric hoists, winches, capstans, the different styles of which are here shown; the second describes coal-handling machinery.

The Fritz & Goeldel Mfg. Co., Grand Rapids, Mich. Illustrated catalogue of drafting room and office furniture, including several styles of drafting tables, drawing boards, blueprint frames, office desks and typewriter desks, railroad filing cases, etc.

The Coburn Trolley Track Mfg. Co., Holyoke, Mass. Booklet calling attention to the Coburn trolley track for carrying materials on an overhead track and saving time and labor. Their No. 20 catalogue gives complete details and will be sent on request.

The Vilter Mfg. Co., Milwaukee, Wis. Catalogues of refrigerating and ice-making machinery; of horizontal Corliss engines; of steam boilers; of buildings for breweries, bottling and ice-making plants (Catalogue C); and of bottlers' machinery and supplies.

The Ingersoll-Sergeant Drill Co., New York. Form 341, "Driving the New York Subway, a short history of this great enterprise, mentioning incidentally the part played by this company's rock drills and air compressors in the construction of the subway.

J. M. Carpenter Tap & Die Co., Pawtucket, R. I. New catalogue, No. 16, and price list of taps, dies, hobs reamers, screw plates, pipe stocks and dies, tap wrenches, etc. They call attention to their very complete list of their round die sets to be here found.

The Ingersoll-Sergeant Drill Co., New York. Pamphlet, "The Storage Air Brake System of the St. Louis Transit Co.," containing a short sketch of this system and referring to the tests of the system made by the Railway Test Commission at the St. Louis Fair.

The Colburn Machine Tool Co., Franklin, Pa. Catalogue "A" of the Colburn universal saw table. This was described in Machinery, July, 1903; also illustrated pamphlet relative to their 72-inch widened pattern vertical boring mill, described elsewhere in this issue.

The American Steam Pump Co., Battle Creek, Mich. Illustrated catalogue No. 12 of the Marsh steam pumps. Boiler feed pumps, plunger pumps, marine pumps, yacht pumps, tank pumps, vacuum pumps are shown. Also air compressors, deep well pumping engines, etc.

The American Blower Co., Detroit, Mich. Bulletin No. 171, descriptive of a new product the "A B C" type vertical, enclosed, self-oiling engine. The oiling system is fully described and the engine is illustrated by a number of half tones showing the different types and details.

The Bayldon Machine & Tool Co., Jersey City, N. J. Advertising card in the shape of an emery disk, calling attention to the company's disk grinders and showing their No. 20 disk grinder, which they state is a reliable machine and furnished at a very low price for a good disk grinder.

The Sprague Electric Co., New York. Bulletin No. 218 showing some of the applications of the Sprague electric motors. These are shown driving radial drills, planers, die presses, various styles of pumps and other machinery. The Sprague [illegible] and spur geared, and an electric winch also appear.

The Chandler Planer Co., Ayer, Mass. Illustrated [illegible] containing description of the Chandler planer which, with the [illegible] high-speed steels, runs at a cutting speed of 60 feet per minute [illegible] at 200 feet per minute. A complete description of this [illegible] published in Machinery, July, 1904, number.

The Evans Friction Cone Co., Newton Center, Mass. 1904 catalogue of the Evans friction cone. Hanging patterns Nos. 5, 6 and 8 are shown and standing pattern No. 9, the first for driving machinery from overhead and the other from the floor. The rest of the booklet is devoted to a very large list of users of this style of drive.

The Joseph Dixon Crucible Co., Jersey City, N. J. Twenty-four page booklet on the subject of graphite for lubricating automobiles and motor boats. The lubricants here described are just for this special class of machinery and the booklet will prove useful to those interested in motor cars and motor boats, to whom a copy will be sent free.

The Columbus Machine Co., Columbus, O. Special catalogue, 1904 of gas and gasoline engines. In addition to their regular line, shown in their previous catalogue, they here illustrate a geared pumping engine and a hoisting engine, recently put on the market. Also a traction engine for agricultural purposes. A list of sizes is also to be found.

The Garvin Machine Co., New York. Booklet descriptive of the solid extended knee which is a prominent feature of the Garvin milling machines. There are no openings either in top or sides, which adds to its stiffness and solidity and makes its use specially desirable for heavy work, obviating chattering. The knee is here fully described.

The Monarch Engineering & Mfg. Co., Baltimore, Md. Pamphlet describing the Steele-Harvey metal melting and refining furnace. It consists of an outer steel shell, lined with a double row of firebrick into which fits the crucible. The furnace can be tilted at any angle and the crucible being always within the furnace loses no heat in cooling off.

The Carborundum Co., Niagara Falls, N. Y. "This Land of Ours," an attractive pamphlet giving interesting historical matter relative to this country generally and in particular about the plant of the above company where carborundum is made. The many and various uses to which carborundum may be put, are here enumerated and illustrations shown.

The Sawyer Tool Mfg. Co., Fitchburg, Mass. Circular showing the company's new line of friction joint calipers (patent applied for). These are outside and inside calipers, and hermaphrodite calipers whose joints have pockets for holding the beeswax for an indefinite period. The joints are adjustable for any desired tension. Complete catalogue furnished free.

The Turner, Vaughn & Taylor Co., Cuyahoga Falls, Ohio. Loose-leaf catalogue of the company's products. These include core machines; steel and cast-iron tub beaters and rubber washers for removing sand, etc.; roll pointers; wire-drawing machines; the Chaser clay mills, double-acting steam press; chain link cutters and winders; oil and gas-burning furnaces, etc.

The Alcolm Co., 200 Broadway, New York. Initial edition of the New York Business Telephone Directory, a copy of which is delivered for every telephone in Manhattan and the Bronx. This enables one to find promptly business addresses and those of professional men, lawyers, doctors, etc. Private addresses are entirely eliminated and the addresses given are classified according to the business or profession. The book will be published twice a year.

The Abendroth & Root Mfg. Co., Newburg, N. Y. Catalogue (with discount sheet) of pipe, spiral riveted, straight seam and punched; and of formed sheets for making up at destination. Different samples of this pipe are shown and quite a number of views of its installation, with testimonials of its efficiency and durability. A number of tables appear and the new style of Root exhaust head is shown. The company also manufacture the Root water-tube boilers, elevators, bilge pumps, flumes, etc.

The Norton Emery Wheel Co., Worcester, Mass. Catalogue of emery and corundum goods and grinding machinery. This book contains 167 pages and appears to be very complete; emery cylinder chucks, bench grinding machinery, floor grinding machinery, the Norton bench tool grinders, countershafts, a lathe grinding attachment, etc., are described. The Norton Co. no longer manufacture or sell the Walker universal tool and cutter grinder but are prepared to furnish a universal tool and cutter grinder, in two sizes, which they can recommend to the trade.

The John M. Rogers Boat, Gage & Drill Works, Gloucester City, N. J. Catalogue No. 7, of small tools. These include fixed caliper and internal and external cylindrical gages and limit gages; measuring machines; corrective gage standards (disks for correcting fixed gages, for setting calipers), etc.; reamers, in many varieties: taper, shell, pipe, inserted blade, spiral fluted, adjustable bladed, etc.; rose reamers, hand reamers, and chucking reamers; and a special adjustable milling tool for milling, facing and centering work in one operation. A number of useful tables also appear.

The A. S. Cameron Steam Pump Works, New York City. Miniature catalogue of steam pumps, a reproduction in part of their complete catalogue. This neat little pamphlet presents a few designs of the Cameron pumps, viz., steam pump for regular service; boiler feed pump; automatic feed pump and receiver; light service pump, with removable bushing; single compound; air pump and condenser; plunger pump; mining pump; sinking pump, etc. The advantages claimed for this pump are simplicity, due to the small number of working parts, and durability, the steam mechanism consisting of four stout pieces only.

The Standard Welding Co., Cleveland, Ohio. "Welding [illegible]" — booklet telling what this company does in the matter of [illegible] welding. Mention is made of some apparently impossible [illegible] have been successfully done by this method. As an example [illegible] steel boiler flues 4 inches in diameter have been welded together to make 30-foot tubes; a pile of bands 14 inches wide 10 feet long at 1-16 inch thick are welded into a continuous belt; a [illegible] sprocket shaft is welded to a steel casting, for use as a brake drum on an automobile, etc. The company state that by their [illegible] of electric welding work is done with far less expense [illegible] effectiveness. The book is sent free upon request.

The Norman W. Henley Publishing Co., 132 Nassau St., New York. Catalogue 9 x 12 of technical books. This is a list of up-to-date works on the following subjects: [illegible] making and interchangeable manufacturing; gas engines; dies; [illegible] steel; compressed air; machine shop tools; patternmaking; perspective drawing; saw filing; liquid air; automobiles; the steam engine; the locomotive; etc. Among them we note as nearly ready "Gas Engines and Producer Gas Plants, by R. F. Mathot, covering the subject of the gas engine; and "American Lathe Practice," by W. H. Vandervoort, covering the latest practice in lathe and boring mill operations. Each book mentioned is the work of a man experienced on the subject of which he writes, and is therefore reliable and valuable. A good description of the works appears in this catalogue, to serve as a guide.

in the selection of them. This catalogue, and their 114-page catalogue of practical books, will be furnished upon request.

CHARLES H. BESLY & CO., 15-21 South Clinton Street, Chicago, Ill. Illustrated catalogue, 1904, of the Gardner grinders, spiral groove disk wheels, Besly band grinders, etc., also of band polishing machines, Helmet cement, Helmet oil, Badger oil cups, and other specialties. The principle of the Gardner grinder and the spiral-groove disk wheel (an essential feature of this tool) are here described, and full directions given as to the methods of operating same. Nine new machines are shown and also two styles of motor-driven Gardner disk grinders, on which can be used any of the well-known makes of motors. A number of pages are devoted to illustrations of the various operations that can be rapidly performed with this tool, such as: Finishing malleable iron wrenches on a No. 6 grinder at the rate of 75 wrenches per hour; grinding a casting (a case for a toothed steering quadrant for automobile) in 90 seconds; grinding 8-inch forgings both sides in 15 minutes, etc. Specifications and prices of each style and size of grinder are to be found, also a good number of testimonials, by users of this tool, expressing their entire satisfaction. The Gardner grinder is used for a great variety of work—grinding and finishing leather, wood, hard rubber, steel, drop forgings, brass, copper, aluminum, cast iron, and an instance is given of a Gardner grinder being used in a marble works for grinding tops of mantelpieces.

ST. LOUIS AWARDS.

The Gisholt Machine Co., Madison, Wis., have been awarded the grand prize at the Louisiana Purchase Exposition.

The E. W. Bliss Co., Brooklyn, N. Y., have received the grand prize and gold medal for tools and machines exhibited at St. Louis.

The Electric Controller & Supply Co., Cleveland, O., announce that they have been awarded the gold medal for their St. Louis World's Fair exhibit.

The Norton Emery Wheel Co., Worcester, Mass., received the grand prize for their grinding machinery at the St. Louis Exposition, also two gold medals for other products exhibited by them.

The Goldschmidt Thermit Co., New York, were awarded the grand prize at St. Louis for their welding compound, thermit; also the Elliott-Cresson medal, which was conferred on them by Franklin Institute.

The Keuffel & Esser Co., New York, have received the highest award at the St. Louis Exposition—the only grand prize for Group 19 (instruments of precision, philosophical apparatus, etc), and a gold medal, for Group 115, instruments and equipments for underground surveying.

* * *

In a paper read before the Coventry Engineering Society, Mr. J. M. Gledhill outlines the process of making shear steel as follows: Five short lengths of blister bar are heated in a hollow coke fire, and which by use of a soft blast admits of being regulated to a welding heat. During this time the surface of the bars is covered with clay beaten fine and applied during the heating to exclude the air and prevent oxidation. The bars are then carefully hammered and welded together. This is known as "single shear" steel. To make "single shear" into what is known as "double shear" steel the bar made of "single shear" as above described is broken in the middle, the two pieces laid together, welded a second time and again drawn to the required shape. By this double operation the steel becomes more homogeneous and of a finer texture, and we thus obtain a material having a hard and steely exterior, and yet possessing a soft interior, thus securing both hardness and ductility where required.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line.

The money should be sent with the order.

MACHINERY.

January, 1905.

HEAVY WORK OF THE PORT RICHMOND IRON WORKS.

THE works of the I. P. Morris Co., Philadelphia, known as the Port Richmond Iron Works, date their origin as far back as 1828. Their history is almost coincident with that of the development of the iron and steel industry of this country, and they have carried through some of the most important engineering work in the way of pumping engines, turbines, blowing engines, centrifugal pumping machinery, etc., that has been done. Among these are included the Boston sewage pumping engine, and the Louisville Pumping Engine No. 3, both designed by E. D. Leavitt. The former of these is the largest in the world and the latter has proved itself the most economical of its type. Other notable installations are the 15,000 H. P. engine for operating the forging presses at the Bethlehem Steel Co.'s works, which have been illustrated in MACHINERY, and much of the massive machinery installed at the Calumet and Hecla Mines, most of which was designed by E. D. Leavitt. As a matter of historic interest, it may also be stated that they have built engines for certain of the monitors used in the Civil War, under the patents of Ericsson; and the old Cornish engines for the Buffalo water works which they constructed were among the first of the kind in the country.

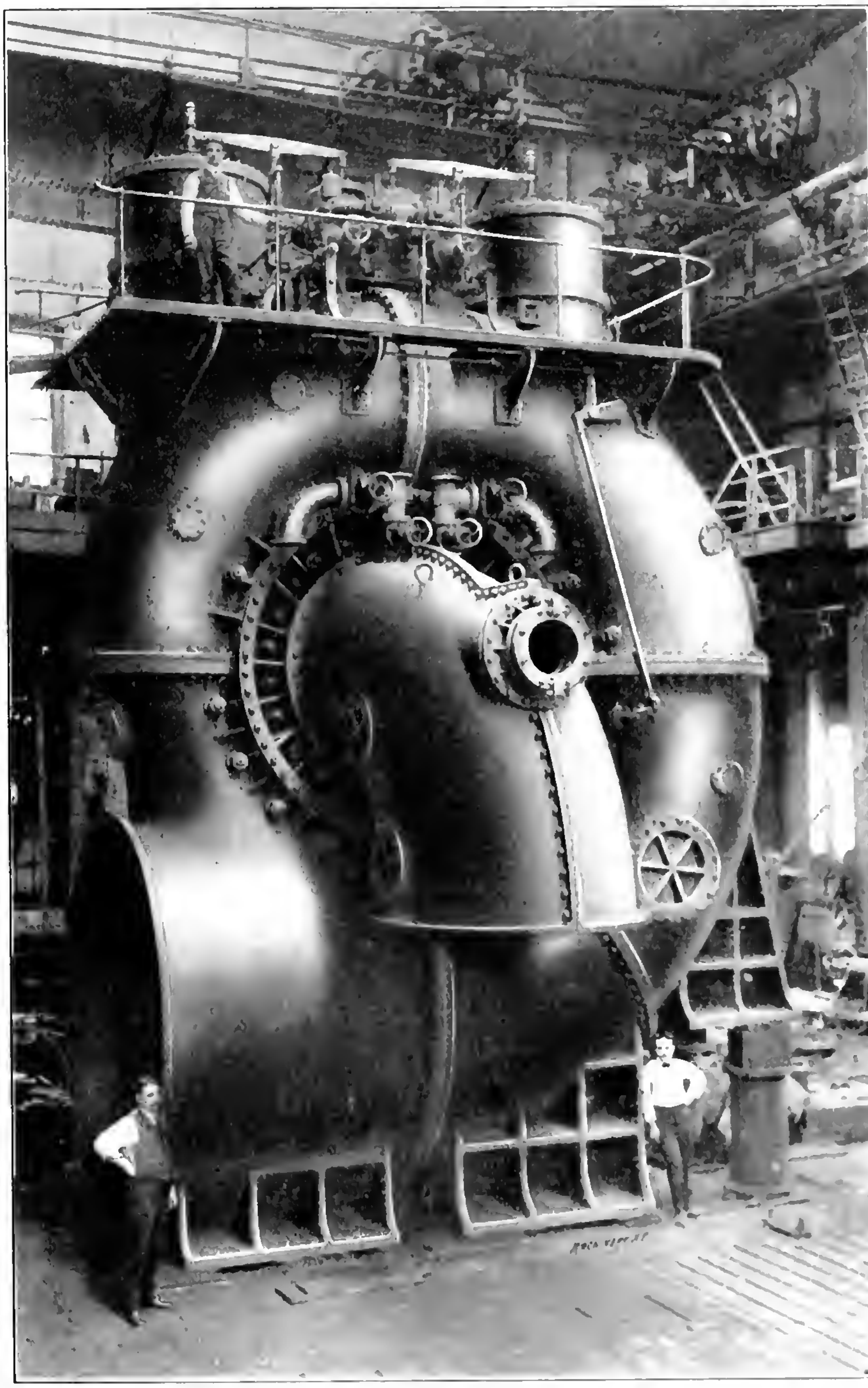


Fig. 1. 10,500 H. P. Turbine for the Shawinigan Water and Power Co., P. Q. Canada

In a bulletin recently issued by the I. P. Morris Co. is given an interesting account of some of the more recent engineering construction carried through by them, and for the account which follows we are indebted to the descriptive matter contained in this bulletin.

Fig. 3 is a view showing the interior of the south bay of the Port Richmond Works, with some of the large turbines of 10,000 H. P. capacity for the Canadian Niagara Falls Power Co. in process of construction. These turbines operate under a head of 145 feet at 250 revolutions per minute, and were built from designs of Escher, Wyss & Co., Zurich, Switzerland. The station will eventually have a capacity of 110,000 H. P.

When the Niagara Falls power plant was projected the I. P. Morris Co. secured the contract to build the turbines—the largest up to that time. The first installation consisted of 10 units of 5,000 H. P. each, and these were followed by 11 larger turbines of 5,500 H. P. for the second plant. An illustration from a photograph of one of the 5,000 H. P. units is shown in Fig. 2 with a portion of the shaft leading to the generator above, and of the elbow connecting the wheel case with the penstock and supporting the latter. It is estimated that the energy produced by the falls of Niagara is the equivalent of more than 7,000,000 H. P., and from this immense amount some 75,000 H. P. is now utilized by this plant, situated about a mile and a quarter up the river on the American side. Here a surface canal 250 feet wide and 12 feet deep leads the water to the power house. The solid masonry walls of the canal are pierced by twenty-one inlets through which the water enters the penstocks in the wheel pits, which are huge excavations 178 feet deep by 18 feet wide and 400 feet long running parallel to the canal, one on either side, about 75 feet away. Penstocks of steel plate $7\frac{1}{2}$ feet in diameter bring the water to the turbines near the bottom of the pit, and these drive the generators vertically over them through shafts 160 feet long or more. The discharge water from the turbines is conveyed from the bottom of the wheel

pits to the main tunnel, and thence into the lower Niagara River. The electric system used is the Tesla polyphase alternating current type, in this case generating a 2-phase, 25 frequency, 2,200 volt current. To consumers within a radius of one or two miles the current is sent, at the voltage generated, over lead-covered cables laid underground in a large conduit and transformed at the user's plant to the required voltage. For the long-distance transmission circuits, to Buffalo and in some instances to points 39 miles away, it passes through similar cables to the transformer house, where it is "stepped-up" to 22,000 volts, at which potential it is carried on overhead wires to sub-stations at the other end, where "step-down" transformers reduce the voltage to suit the local demands. The plant is so constructed that the available H. P. is 110,000, and this development may be made without a perceptible diminution of the flow over the falls.

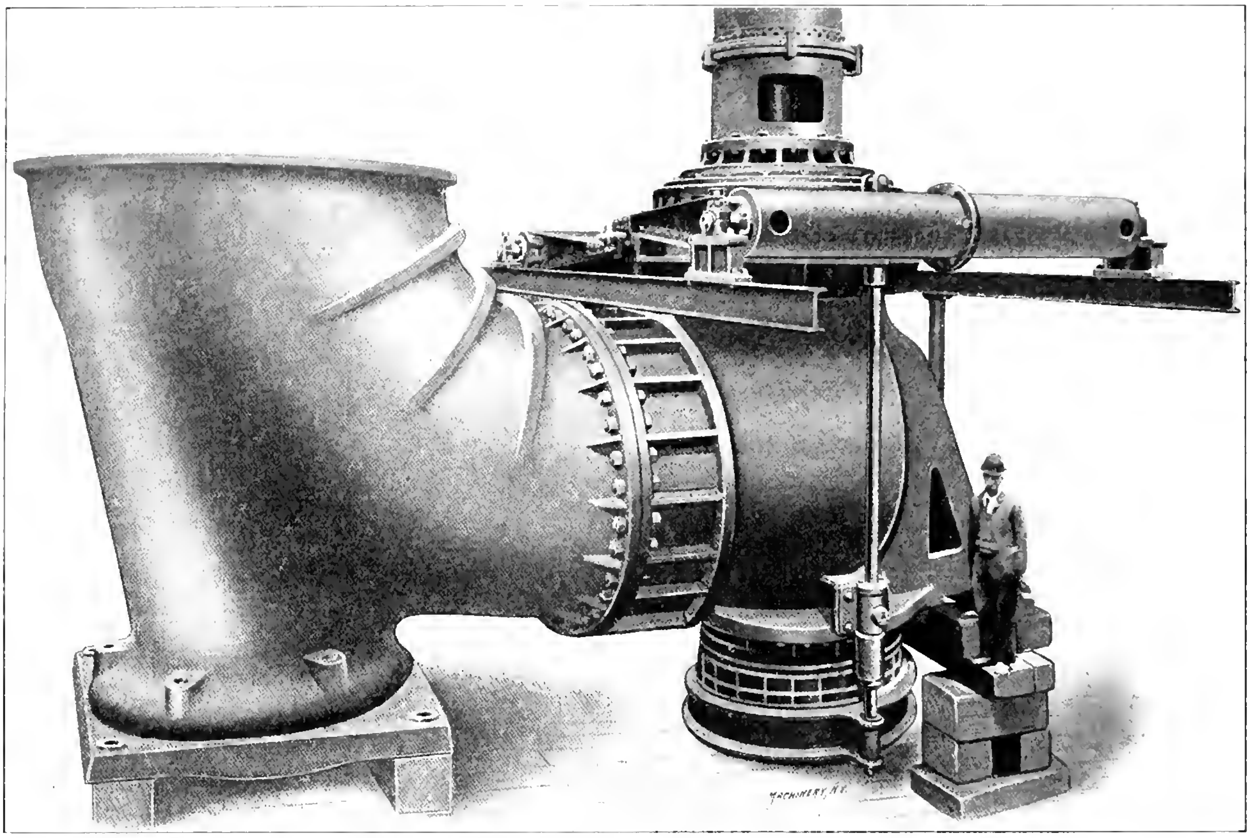


Fig 2 One of the 5,000 H P Turbines in Power House No 1 of the Niagara Falls Power Co. Shows Elbow connecting Wheel Case with Penstock.

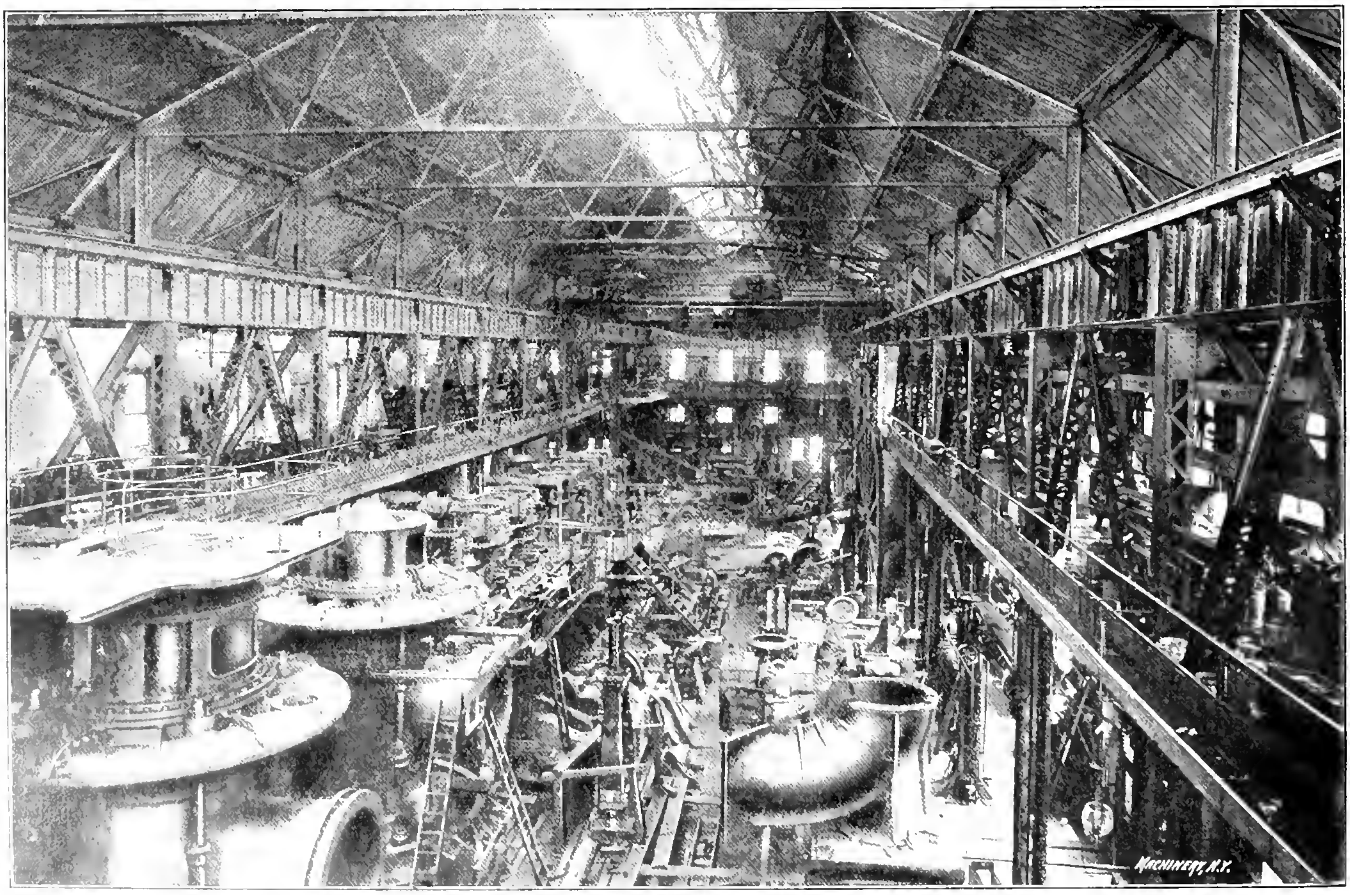


Fig 3 South Bay of Machine Shop, I P Morris Co., Philadelphia, showing 10,000 H P Turbines in Process of Construction.

In Fig. 1 is a view of a wheel of 10,500 H. P. now being installed by the I. P. Morris Co. at the plant of the Shawinigan Water & Power Co., Shawinigan Falls, province of Quebec, Canada. This is believed to be the largest water power unit ever constructed, and is one of four located at this plant, three of which were built by the Port Richmond Works. The plant is 84 miles northeast of Montreal, and is an ideal location for the generation of electricity by water power. Not only is there available a high head, a large quantity of water and a nearly constant flow, but the river widens out to a "lake" both above and below the falls and makes a right angle bend between the two lakes, thus bringing the upper and lower water levels within a short distance of each other and providing a convenient and economical location for the plant on the slope between the lakes. The company has purchased property on both sides of the river for factory sites and operatives' houses, for it is hoped that various industries will be attracted by the cheap water power. Already the wilderness of five years ago is a substantial city of 5,000 inhabitants, and this development has been accomplished without marring the natural beauty and surroundings of Shawinigan Falls. The power capacity of the stream at this point is estimated at 125,000 H. P., and the plant is so built that an ultimate development of 100,000 H. P. is possible when such an amount of power can be profitably disposed of. From the south end of the upper lake a canal 20 feet deep and 1,000 feet long was excavated through rock to a point where, in a distance of 500 feet, the ground makes a drop of 140 feet. At this point the canal was closed by a concrete wall containing outlets for six penstocks, each 9 feet in diameter. Three penstocks 150 feet in length carry water to a like number of turbine wheels in the power house, and two other somewhat longer penstocks lead to the power house of the Northern Aluminum Co., which purchases its power in the hydraulic form, using its own turbines and generators. Each of the three penstocks supplying the Shawinigan Falls Power House furnishes water to a 6,000 H. P. horizontal-shaft turbine direct-connected to a 3,750 K. W. revolving field generator giving a quarter phase, 2,200 volt, 30-cycle current. The new wheel now being installed is of the horizontal shaft inflow type, with spiral casing and draft tube on each side through which the water discharges outward from the center. The spiral casing permits the penstock to be received below the floor of the power house, thus leaving room for oil switches under the switchboard gallery. The design includes a hydraulic hand gear mechanism and other novel features. The wheel is designed to operate under a normal head of 135 feet. Of the present output of the plant about 10,000 H. P. is transmitted over long-distance lines 84 miles to Montreal and there used for street railways, electric lighting and general power purposes. The current is stepped up at Shawinigan to 50,000 volts, three phase, and carried over three cables to Montreal, where it is stepped down, with a loss of about 18 per cent in transmission. A second line to Montreal to carry another 10,000 H. P. is now being built, and a third is in contemplation.

Another plant in which the I. P. Morris Co. has installed machinery is the Niagara Falls Hydraulic Power & Mfg. Co., located on the bluff above the lower Niagara River. While the turbines in this plant are only about one-fourth the size of the one just mentioned, they are still very large and give a high degree of efficiency. The water is supplied by a surface canal

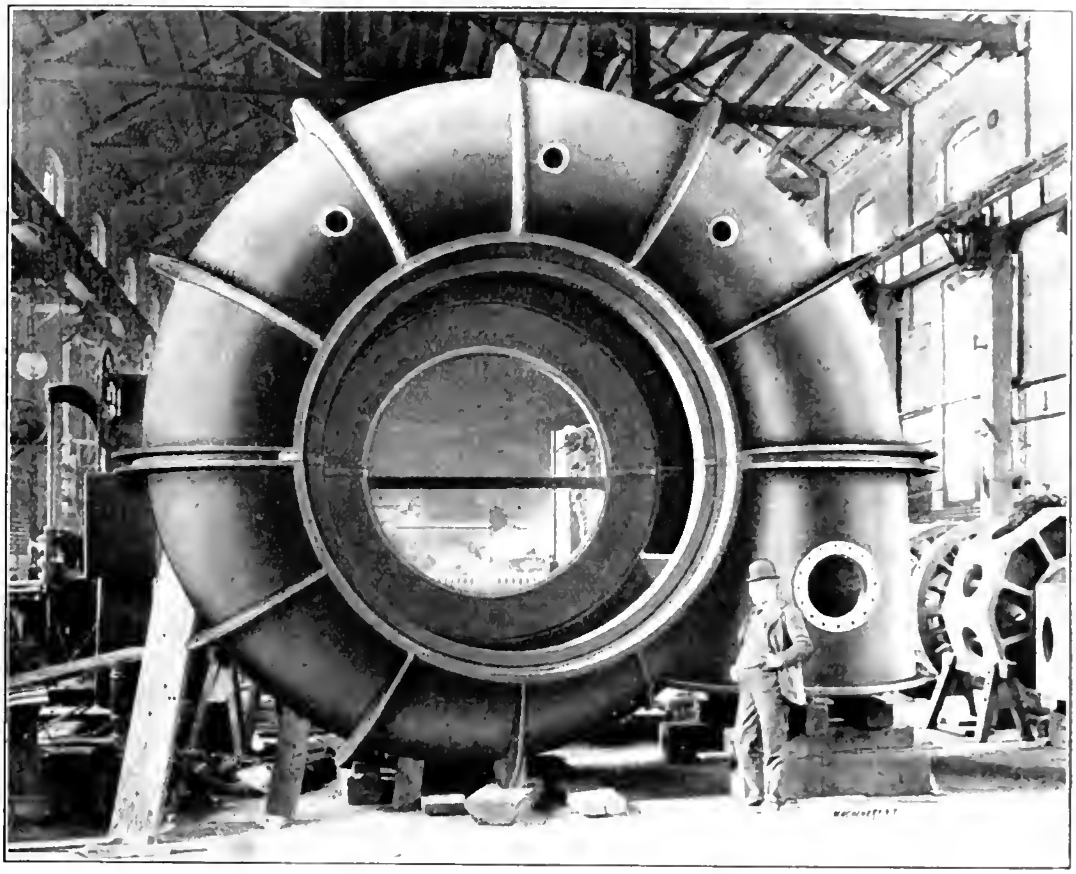


Fig. 4. Volute Casing of Vertical Shaft Centrifugal Pump for the Metairie Pumping Station, New Orleans, La. Diameter of Discharge, six feet. Said to be the Largest Pump made

running from the upper river through the city, a distance of 4,400 feet, to a reservoir on the bluff, whence it flows to the various mills and is discharged by short tunnels through the bluff into the river below. A new power house has now been built at the foot of the cliff where the entire available head of water can be utilized with a consequent increase of power; moreover in this way the need for long transmission shafting is avoided. The water is led from the canal to the wheels through huge penstocks which pass down over the bluff. The total present output of this plant is about 35,000 H. P.

Two large turbines now in course of construction at the Port Richmond Works are destined for the plant of the Canadian Niagara Power Co., which is now erecting its third power house on the Canadian side of the upper Niagara River. Its hydraulic features will be similar to those of the Niagara Falls Co., with which it is to operate in parallel. The units will, however, be of 10,000 H. P. capacity, and the generators will be wound for 11,000 volts, three-phase. The turbines are of the Francis inflow type with draft tubes on either side, and they share with the 10,500 H. P. unit built for the Shawinigan Co. the distinction of being the largest turbines constructed up to the present time. Another plant equipped by the I. P. Morris Co. is the Trenton Falls Plant of the Utica Gas & Electric Co. The power house is fitted up with four vertical shaft turbine units of 2,100 H. P. each direct connected to generators. This hydraulic plant gives very satisfactory service inasmuch as it is almost constantly run at its full capacity, and has established the record of a load factor of 98 per cent of the full output.

Another branch of hydraulic machinery to which the I. P. Morris Co. have devoted much care and attention is the construction of centrifugal pumps, and their most notable work in this line has been in connection with the pumping stations of the New Orleans Drainage Commission. At the Metairie Pumping Station, New Orleans, they recently installed

a vertical shaft centrifugal pump, the volute casing of which is shown in Fig. 4. This pump has a diameter of discharge of 6 feet, a diameter of impeller of 9 feet 4 inches, and a capacity of 320 feet per second at the lift of 10 feet, with an efficiency of 74 per cent. This is believed to be the greatest quantity of water ever discharged by a single pump. This pump is driven by a direct-connected 500 H. P. alternating current motor. Three centrifugal pumps of the horizontal shaft type have been installed in St. Bernard Pumping Station No. 3, also at New Orleans. These are all driven by direct-connected motors, and consist of one "constant service" pump having a capacity of 50 cubic feet per second with a lift of 12 feet, and two "special service" pumps lifting 8 feet with a capacity of 250 feet per second. Each of the larger pumps has a discharge of 6 feet diameter at the pump, enlarged to 10 feet diameter at the discharge basin. To secure the highest possible efficiency, centrifugal pumps and turbines should be designed for the particular lift, capacity, and speed at which they are to operate, in order to better meet the conditions under which they will be required to work.

* * *

HIGH-PRESSURE OILING SYSTEM FOR HEAVILY LOADED BEARINGS.

Almost every one who has had anything to do with the operation of machinery, knows that "friction of rest" is much greater than "friction of motion," or, in other words, that more force is required to start a machine than to maintain the motion without load. The reason, of course, is that the journals sink down into their bearings and displace the oil films so that there is actual metallic contact, which causes them to drag heavily until the oil films are re-established. There is one serious feature of this well-known fact that, we believe, generally escapes attention, and that is the damage often done on heavily-loaded bearings during the starting period. A babbitt bearing may be badly scored at this time although it would give no trouble from heating afterward. In a recent issue the *Engineering Record* tells how this trouble is avoided in the plant of the Puget Sound Power Co. The main shaft of each 3,500 K. W. unit is of fluid-compressed nickel steel, with journals 16 inches in diameter, which are supported by babbitted surfaces 4 feet long. In addition to special oil grooves cut into both the top and bottom halves of the bearing, there is a special high-pressure oil groove not connected with any of the others. This is located vertically under the axis of the shaft, and connection is made to it by a flexible high-pressure oil pipe from a motor-driven oil pump supplying oil at 2,000 pounds per square inch. This system is only used in starting the wheels in order to avoid damaging the babbitt surface, as the rotating element weighs in excess of 98,000 pounds. A centrifugal oil circulating system is otherwise provided so that the bearings may be flooded with an additional amount of cool oil if heating occurs. In each bearing a pair of thermostats is connected in parallel in an electric circuit for indicating at the switchboard a dangerous temperature rise in any of the journal bearings.

* * *

ANNUAL MEETING OF THE A. S. M. E.

The fiftieth meeting of the American Society of Mechanical Engineers was held in New York December 6 to December 9, as announced in the last number. The papers read were mostly of a highly technical character, there being fewer of a popular nature than has been the case for several years. The president's annual address on the evening of December 6 is abstracted in another part of this issue and following this Mr. C. W. Hunt addressed the society to present on behalf of an unnamed donor a portrait of Prof. John E. Sweet, one of the founders of the society. At the last session of the meeting Mr. James N. Dodge, of Philadelphia, also presented the society with a bronze bust of Capt. John Ericsson, made from a plaster bust of the great engineer, which was produced while Ericsson was alive.

The membership during the past year has increased largely, there now being 2,800. The expenses, however, exceed the income from dues of nearly $3 per member, and the dues, together with all other sources of income, are not sufficient to pay the running expenses of the society. The reports were given of the progress of the different committees on the Union Engineering Building and as a matter of course, much interest centered in this. Abstracts of some of the papers appear elsewhere in these columns and a brief sketch of the new president, Mr. John R. Freeman, Providence, R. I., together with his portrait, is published herewith.

The New President.

John R. Freeman, the newly-elected president of the American Society of Mechanical Engineers was born in 1855 in West Bridgeton, Maine. His early schooling was secured in West Bridgeton, and in later years he continued his studies at the public schools of Portland, Me., and Lawrence, Mass., finishing at the Massachusetts Institute of Technology, from which he was graduated in 1876, as civil engineer. His first position upon leaving the Institute was with the Lawrence Water Power Company, in whose employ he remained for a number of years, and where he acquired a vast knowledge of hydraulic engineering. He then took a position with the Factory Mutual Fire Insurance Companies as inspector, with a view to acquainting himself with the insurance business. He became particularly interested in fire protection engineering and, being made chief inspector and chief engineer, began a

John R. Freeman.

series of tests and investigations by which he was enabled to bring about many improvements and introduce many new methods. In 1896 he became president of the Manufacturers' Rhode Island & Mechanics' Mutual Fire Insurance Companies, whose business has increased greatly under his supervision. Recently he was made president and treasurer of three more insurance companies.

Mr. Freeman is also a member of the American Society and the Boston Society of Civil Engineers, of which latter society he was president in 1893. He has written several papers of great interest and value, among them one on the "Hydraulics of Fire Streams," and another on the "Nozzle as a Water Meter," for which he received the Norman medal awarded by the American Society of Civil Engineers.

* * *

Over 25 miles of one-inch steam pipe will be used in the hot blast heating and tempering coils to be installed by the American Blower Co. in the new Wanamaker store in Philadelphia. This pipe is being manufactured into one hundred and eleven heater sections, varying in capacity from 35,000 to 36,000 feet of heating surface. Twenty-eight ventilating fans will be used in the building, the largest having a housing of 220 inches and the smallest of 30 inches. The completed apparatus will make a 10-carload shipment. An "ABC" apparatus, of seven large fans and some 44,000 feet of 1-inch pipe, is also to be installed in the New York Wanamaker building.

A REVIEW OF STEAM TURBINE PATENTS.—3.

Seger, 1894.

Seger's turbine has been built and used to some extent abroad. His first patent specification, issued in 1903, shows an arrangement of wheels indicated in Fig. 36. Like Pilbrow and B. T. Babbitt, he seeks to secure a moderate speed of rotation by using two wheels turning in opposite directions.

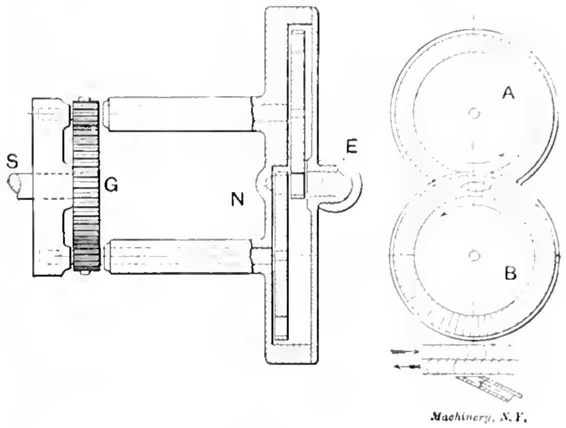


Fig. 36. Seger's First Patent.

The steam, in leaving the first wheel, impinges directly against the second without any intervening guide vanes. The turbine wheels, *A* and *B*, are on separate, parallel shafts, and at *G* are the gears by which the motion of the wheels is transmitted to the driving shaft, *S*. *N* is the nozzle through

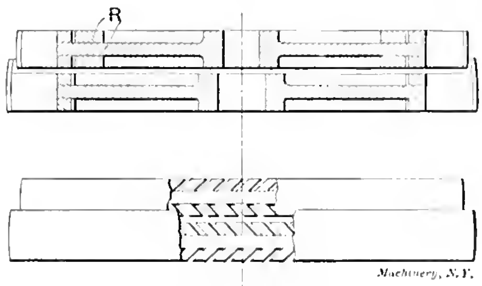


Fig. 37. Arrangement of Wheels.

which steam enters, and *E* the exhaust passage. His claim is for "a steam turbine in which the turbine wheels are placed in close proximity to each other, and are combined with one or more steam conduits discharging into the sides of said wheels in such a manner that the steam passes through the

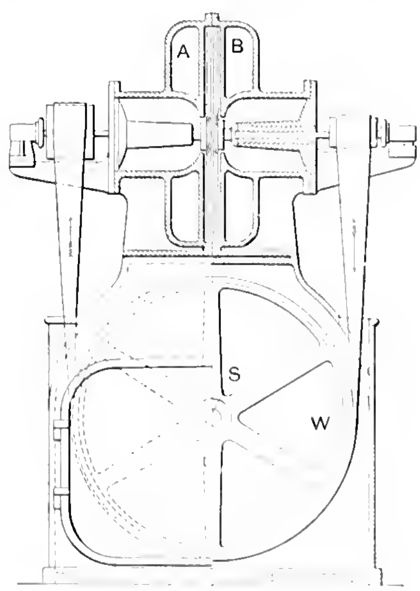


Fig. 38. Sectional Elevation of Seger Turbine

wheels in the direction of their axes; and in which the shafts are arranged out of line with each other so that the wheels only partly overlap each other."

In his patent of 1894, Seger shows wheels arranged on the same axis, but rotating in opposite directions. A feature of the patent is the method for fastening the buckets in diagonal slots cut in the wheel rims. The lower view, Fig. 37, shows these slots, and in the upper view the rings, *R*, formed inside the rim, hold the projecting ends of the buckets in position. This construction will be evident from Fig. 39, where *A* is one of the buckets. At *B* the bucket is placed in the rim and at *CC* its projecting ends are bent over underneath the rim. In 1897 Seger issued an English patent upon an arrangement of his turbine by which the belted connection could be used for driving the low-speed shaft, Fig. 38, from which power is taken. Here *A* and *B* are the turbine wheels rotating in

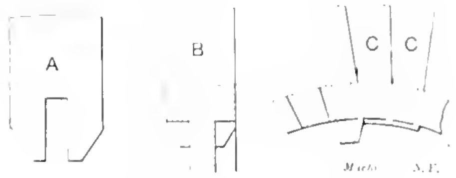


Fig. 39. Vanes of Seger Turbine

opposite directions and attached to the ends of shafts which carry, at their outer ends, small belt pulleys. On the shaft, *S*, are two pulleys, *W*, of equal diameter, one of which is fast to the shaft, while the other is loose on the same shaft. The belt passing around these several pulleys, as indicated, transmits power from the turbine wheels to the main shaft.

McElroy, 1894.

This year marks the beginning of the important patents on turbine wheels of the Pelton type for use with an elastic fluid. Two patents were issued, one to J. F. McElroy in this country, and one in England to Professer A. Rateau. The arrangement of the nozzles and wheel of McElroy's invention is shown at *A* in the sectional view, Fig. 40. Nozzles with diverging mouthpieces are used. At *B* is a section of a bucket in a plane parallel with the shaft, together with an enlarged view of one of the nozzles. At *C* is a section through a bucket taken in the other direction. While an efficient type of bucket

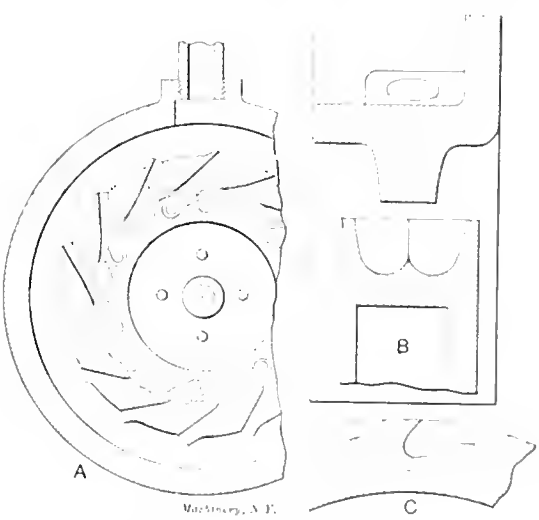


Fig. 40. An Early "Pelton" Type

is shown, and McElroy's claims as to its shape are broad, taken by themselves, they are combined with certain other constructive features which limit the scope of the patent. What he claims is, first, a wheel comprising a solid metal ring having a series of inclined pockets therein, the pockets of each pair being divided by a tapering ridge, in combination with a circular steam ring having a circular series of nozzles, and secondly, pockets as above described, but with a flat inclined cut-away portion for each, as shown in the sketch.

Rateau, 1894.

Professor Rateau, of Paris, was one of the earliest to experiment with a steam turbine having a single wheel of the Pelton type. The essential features of his English patent on this are shown in Figs. 41 and 42, which represent the wheel vanes. He intended primarily to produce a reversible wheel and uses buckets projecting radially, with double concave surfaces, *A*, *B*, Fig. 41, which form a dividing wedge at the center, just as in the Pelton water wheel. For reversing the direction of rotation, he uses steam jets flowing in the oppo

site direction and impinging against the backs of the blades. The backs are shaped as shown at *C*, with a single concave surface, instead of with the double curve, in order to avoid any obstruction to the steam when running in the normal direction. While the single curve is less efficient than the double curve, it answers the requirements for the brief periods during which the turbine has to be reversed.

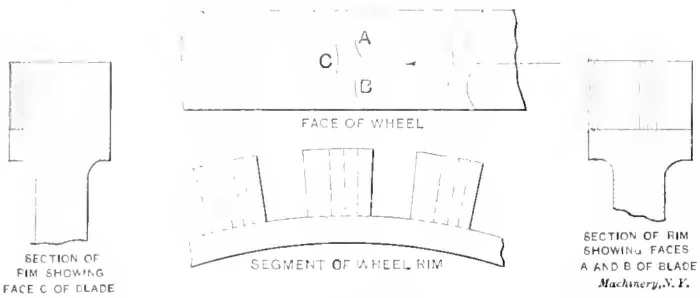


Fig. 41. Rateau's Reversing "Pelton" Wheel.

When the wheel is to be designed for forward motion only, Rateau presents the construction of Fig. 42. *A* and *B* are two concave vane surfaces and at the rear of each bucket an inclined groove, *C*, is cut, represented by the dotted line, *bp*, in the upper view. This allows the jets of steam to strike the buckets, one after the other, without interference from the successive buckets as they come into position. The sec-

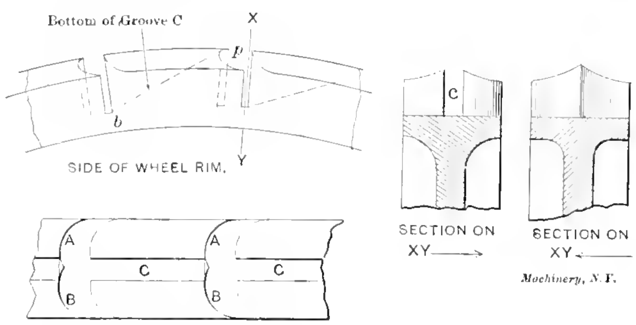


Fig. 42. Wheel for Forward Motion only.

tional views at the right are taken on the line, *XY*, looking, in each case, in the direction of the arrow drawn under each view.

While it is not introduced as a definite claim in this patent, Professor Rateau mentions that where the speed of the fluid is too great it may be necessary to arrange these turbines in series on the same or independent shafts, in which case the openings of the nozzles should all be designed to deliver the same relative quantity of fluid at the same moment. This he would accomplish by using distributing valves for supply-

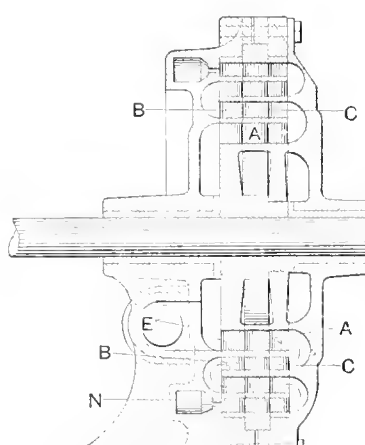


Fig. 43. Novel Compound Turbine.

ing steam to the nozzles, and having these valves all operated positively from the same source so that they would act in unison.

Pyle, 1895.

The patent issued to G. C. Pyle for the turbine shown in Fig. 43 is a variation on the usual plan for compounding. *AA* is a stationary disk, containing the rows of guide vanes, and *BB* are rotating disks. Steam enters through the nozzle, *N*, and passes longitudinally through several vanes in the direction of the arrows, until finally it exhausts at *E*.

Parsons, 1895.

In the method of governing used on Parsons turbines, an oscillatory motion is given to the throttle valve by an eccentric driven by the turbine, and the extent of this movement is controlled by a governor. In the illustration, *A* is a double-seated valve attached to a valve stem, *B*, which is connected with a piston, *C*, working in a cylinder above the valve chamber. At *D* is a pilot valve for controlling the motion of the piston. The steam enters the chamber, *E*, and flows downward through the valve to the turbine. An opening from *E* to the space below the piston allows the steam to push the piston upward against a spiral spring which pushes it downward in case the steam pressure underneath the piston is relieved. When pilot valve *D* closes the port leading from the space below the piston, the pressure maintained under the piston causes the latter to rise and with it the valve *A*, but when valve *D* uncovers the port, steam escapes from under the piston and passes around to the top, and together with the spring serves to close the valve.

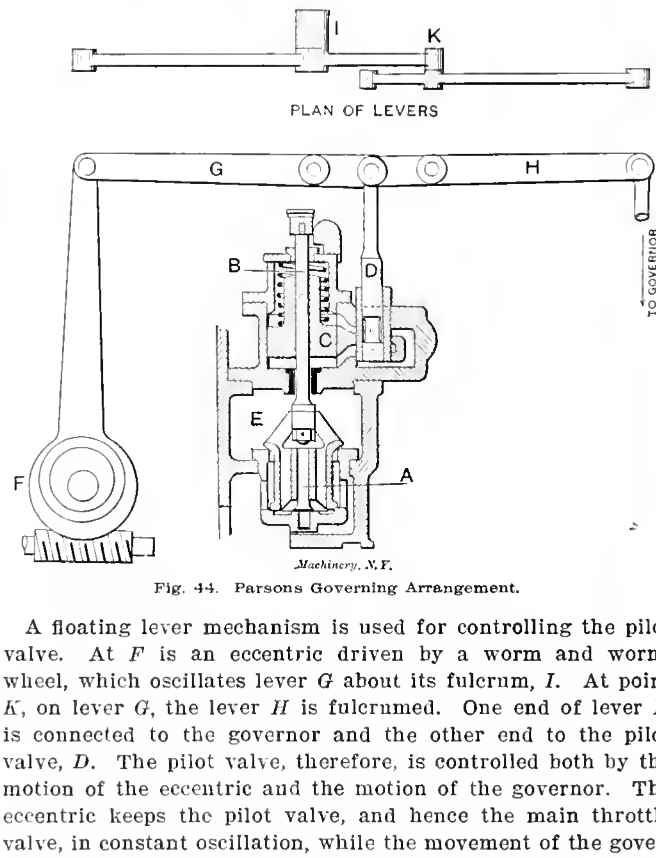


Fig. 44. Parsons Governing Arrangement.

A floating lever mechanism is used for controlling the pilot valve. At *F* is an eccentric driven by a worm and worm-wheel, which oscillates lever *G* about its fulcrum, *I*. At point *K*, on lever *G*, the lever *H* is fulcrumed. One end of lever *H* is connected to the governor and the other end to the pilot valve, *D*. The pilot valve, therefore, is controlled both by the motion of the eccentric and the motion of the governor. The eccentric keeps the pilot valve, and hence the main throttle valve, in constant oscillation, while the movement of the governor changes the positions of the limits of this motion. For example, if the turbine were running with a light load, the valve would oscillate in the lower end of its possible path of travel and would shut off steam entirely at each oscillation; but if the turbines were heavily loaded, the valve would be moved upward by the governor and its path of travel would be located higher, so that steam would flow through the valve continuously, although it would be throttled more or less as the valve moved up and down under the action of the eccentric.

Sebastian Z. de Ferranti, 1895.

The patent taken out by this inventor is to be classed with Hartman's patent of 1858 and that of the Societe Anonyme Maison Breguet, 1894. All three of these propose a compound turbine containing certain features employed in the Curtis patents now used by the General Electric Co. It is to be noted, however, that, like his predecessors, Ferranti fails to specifically state that he wishes to employ a diverging nozzle in combination with a compound turbine, which is an important feature of the Curtis type of wheel, although he says that he intends to utilize fluid in the wheel, "after complete

expansion and the acquisition of the maximum velocity," which, under certain conditions, can only be attained in a diverging nozzle. He advocates the use of superheated steam and also refers to gas turbines. The following is an extract from his specifications:

"I construct impact engines in which the working fluid impinges after complete expansion and acquisition of the maximum velocity, upon semi-circular rotating blades fixed round

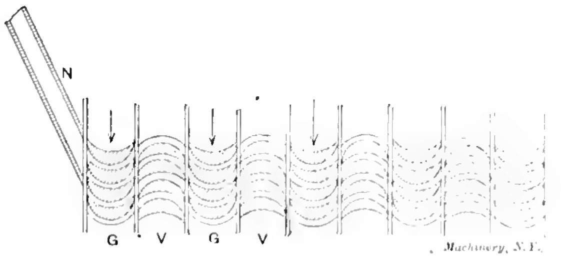


Fig. 45. One Plan for Compounding.

the rim of a motor wheel. The working fluid enters the blades at a high velocity and has its direction reversed, a portion of its energy being turned into work, and rotates the wheel, and then leaves at the other side of the blades at a diminished, though still high velocity. I then pass it through a set of standing semi-circular blades of exactly the same description as the rotating blades, but grooves in the opposite

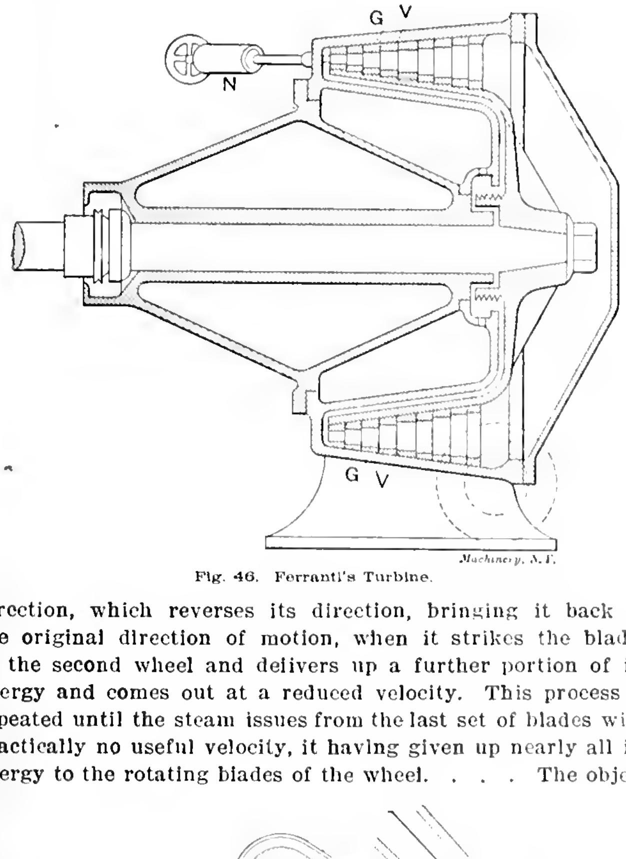


Fig. 46. Ferranti's Turbine.

direction, which reverses its direction, bringing it back to the original direction of motion, when it strikes the blades of the second wheel and delivers up a further portion of its energy and comes out at a reduced velocity. This process is repeated until the steam issues from the last set of blades with practically no useful velocity, it having given up nearly all its energy to the rotating blades of the wheel. . . . The object

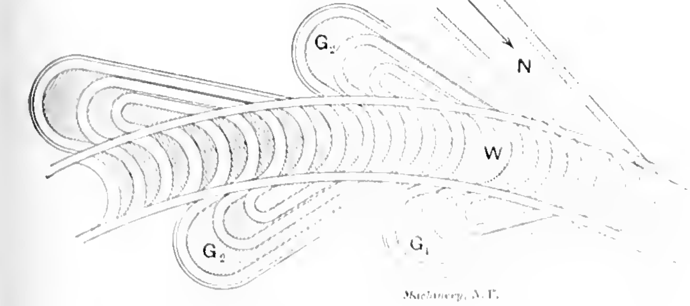


Fig. 47. A Second Plan for Compounding.

is to convert the whole of the energy and pressure in the working fluid into velocity of the particles, which then react backward and forward through the rotating and standing blades of the machine, thus constituting an impact multiple re-active engine.

"The engine may be made with one or more expansion tubes according to the power it is desired to obtain. More or less of these expansion tubes may be used and actuated by the governor according to the power required for the time being. . . . The expansion tubes stand tangentially from the periphery of the wheel and at a slight angle to the side of the wheel so as to deliver its working fluid in the most suitable position."

Fig. 45 shows the principle of his scheme, N being the nozzle, G a set of rotating vanes, V stationary guide vanes reversing the direction of motion, and so on. The design of turbine proposed by him is illustrated in Fig. 46, where N is a nozzle and V and G the rotating and guide vanes respectively, the rotating vanes being attached to a conical drum on the end of the turbine shaft and the guide vanes attached to a casing on the turbine. In this design he plans to have an increasing area for the steam as it flows through the turbine, after Parsons' plan, which is somewhat contrary to the statement of his specifications. In Fig. 47 is still another proposed arrangement in which the steam, directed by the nozzle, N, impinges against the wheel vanes, W, and is then taken up by the U-shaped passages, G_1, and returned to the wheel vanes, where it is again taken up by the U-shaped passages, G_2. This is another modification of the schemes advanced by Wilson, Perrigault & Farcot and a number of other early inventors, and, as previously stated, later by Profs. Riedler and Stumpf.

Curtis, 1896.

The important group of patents taken out in this year by Mr. C. G. Curtis, inventor of the turbine manufactured by the General Electric Co., covers most of the basic principles of this turbine. The leading feature of the Curtis machine is the combination of a diverging or expanding nozzle with a compound turbine wheel, although other features are included which had been found by the inventor to be necessary to the successful operation of a turbine of this form of construction. As already stated, previous inventors have patented turbines

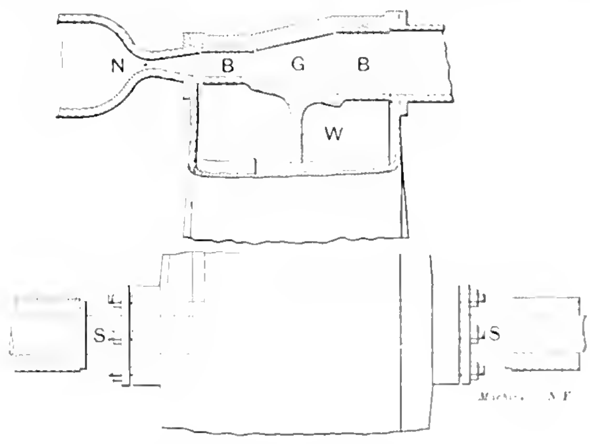


Fig. 48. Curtis' Turbine.

in which was arranged a nozzle for directing the steam against the blades of the rotating wheels of a compound turbine, but the Curtis patents are the first to clearly claim the diverging nozzle as a part of the combination, and they are, furthermore, the first ones to fully explain a practical method for carrying out the design so as to make an operative and economical machine. While the requirements for the successful operation of a compound impulse turbine were outlined by Moorhouse in his patent specifications of 1877, in which he provided for the progressive expansion of the steam from inlet to exhaust by using passages of gradually increasing areas, his patent was limited to the type of construction having a succession of compartments, in each of which is a single turbine wheel.

In Fig. 48 are shown the elements of the Curtis turbine. The shaft, SS, carries a turbine wheel on which are two annular rows of buckets, BB. At N is the expanding nozzle for directing the steam against the first ring of buckets, after which it passes through a group of guide vanes, G, to the second ring of wheel buckets. In the operation of a turbine of this type the ideal condition would be attained if the expansion of the steam could be complete in the nozzle and then it were to pass through the turbine in virtue of its inertia, giving up a part of its velocity to the first ring of buckets and the balance to the second or succeeding rings. This would allow the wheel to run at a comparatively low velocity,

depending upon the number of times the wheel was compounded. That is, if there were a single wheel, as in the De Laval type, it should run at approximately half the velocity of the steam; but if there were two wheels instead they could be run at a lower velocity so that the steam in leaving the first wheel would have a residual velocity to be taken up by the second wheel. By carrying the compounding still further a still slower speed of rotation could be used. Steam, however, is an elastic body, easily diffused, and has so small a mass that its inertia will not carry it through a succession of vanes in the above manner, unless there is an additional propelling force generated to overcome the frictional and other resistances during the passage through the vanes. This is

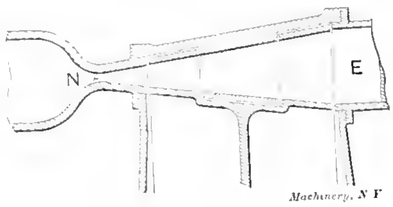


Fig. 49. Preferred Construction for Curtis Turbine.

accomplished in Fig. 48 by reversing a part of the expansion of the fluid to take place in the guide passages, *G*, which, as shown, are made diverging for the purpose. Accordingly, after the steam leaves the first set of vanes it receives an additional impulse in the guide passages before coming in contact with the second set of vanes. The preferred construction, however, and the one which is actually employed, is shown in Fig. 49. Here the steam is expanded in the nozzle, *N*, to nearly, but

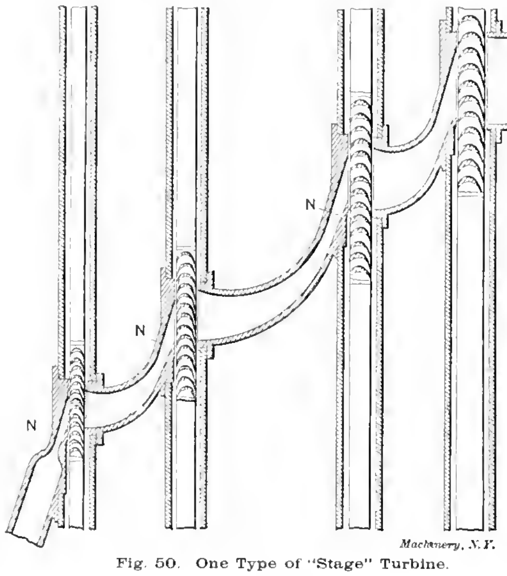


Fig. 50. One Type of "Stage" Turbine.

not quite the final pressure of the exhaust pipe, *E*. The balance of the expansion occurs during the passage between both the rotating and stationary vanes, and the pressure within these passages is, therefore, slightly in excess of the pressure within the chamber in which the wheel is rotating.

In Figs. 50 and 51 are sketches from the so-called "stage patents" of the Curtis turbines. In Fig. 50 each individual wheel is enclosed in a separate casing. Steam is directed to the first wheel by a diverging nozzle, *N*, thence it flows

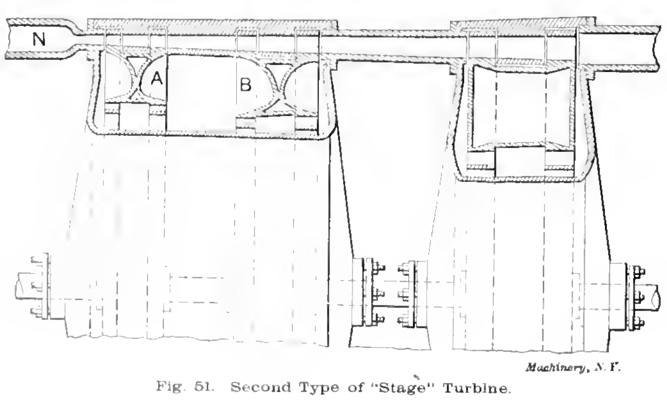


Fig. 51. Second Type of "Stage" Turbine.

through an enlarged passage, to take care of the increased specific volume of the steam, to a second diverging nozzle, *N*, which directs it against the second wheel and so on through the series. This drawing, while differing in details from the plan advocated by Moorhouse, follows very closely the principles outlined by the latter in his patent of 1877 except that Moorhouse apparently did not contemplate the use of expanding nozzles. The illustration, Fig. 51, shows each stage to be composed of one or more of the compound elements that go to make up the turbine represented in Figs. 48 and 49. In each of the two stages shown the wheel-and-bucket arrangement differs one from the other. In the first casing are wheels *A* and *B*, each carrying two sets of rotating rings or vanes, and in the second casing is a single wheel with two sets of blades. The advantage of dividing the turbine into

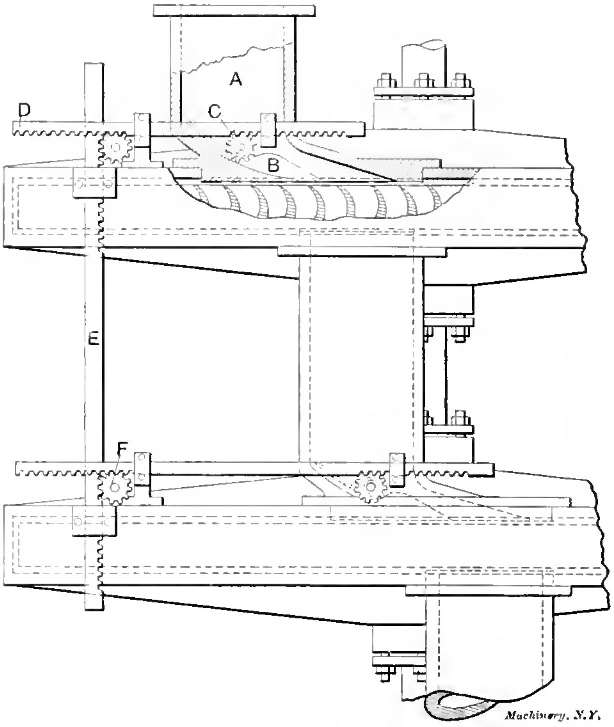


Fig. 52. Curtis plan for Governing a Compound Turbine.

stages in this way, is that there is less leakage between the guide vanes and the wheel vanes, since the differences of pressure are less; and there is also less diffusion of the steam since the number of rows of vanes for the steam to pass through in each stage is less than would be the case if all the rows were combined together in one casing and the steam were compelled to pass through them in virtue of the velocity acquired in the nozzle at the beginning.

A third patent taken out in this year deals with the problem of governing, and Mr. Curtis shows methods for changing the quantity of steam supplied to the turbine without throttling the pressure or reducing the velocity of flow. Obviously an expanding nozzle of certain proportions is adapted only to the steam pressure for which it was designed, and when the pressure is throttled the nozzle does not operate at its highest efficiency. It is proposed by Mr. Curtis to avoid this by using a nozzle of rectangular cross-section with one side adjustable in or out, regulating the quantity of steam flowing through the nozzle without making a great change in the ratio of the inlet and outlet areas. In Fig. 52 is a diagram showing the principle proposed, where the turbine is divided into two or more stages. *A* is the steam inlet, terminating in a nozzle having a sliding piece, *B*, operated by the rack, *D*, and pinion, *C*. This rack gears with another pinion, which transmits motion through the rack, *E*, to the pinion, *F*, and this in turn operates a similar sliding piece in the nozzle, directing steam against the second nozzle. The claims for the apparatus as used with a compound turbine cover first the principle of governing by changing the volume without great variations in the velocity of the steam, and second, the simultaneous and proportionate adjustment of the several passages leading to the turbine or connecting the different stages of the turbine.

PATTERN SHOP OF THE U. S. NAVAL GUN FACTORY.

EDWIN M. BIRRELL.

At Washington, the national capital, the U. S. government has established a plant for manufacturing the arms and armament of the ships of our navy. The Naval Gun Factory occupies what was formerly the Washington Navy Yard, and is situated on the Anacosta River, a branch of the great Potomac. The old buildings have nearly all been remodeled or torn down, and new shops built and equipped with machinery of the latest design. Large tracts of adjoining land

Fig. 1. Exterior of Pattern Shop—one of the Finest in the Country.

have been purchased for the extensions that will naturally take place on account of the great amount of work required to properly arm and equip our growing navy. The converting of the navy yard into the Naval Gun Factory was commenced under the administration of Hon. W. C. Whitney, Secretary of the Navy, and has grown from a small plant doing repair work on the ships to the present efficient one, capable (except for the heaviest forging and casting) of doing any of the work required in the manufacture of all guns and their mounts now in use in the navy. In this plant the government has gathered mechanics of the various trades from all parts of the country, and at the time of writing the force amounts to about 3,800 men.

One of the most important parts of the plant is its pattern shop. While the city of Washington outside the Naval Gun Factory employs fewer than half a dozen patternmakers, in this shop about fifty men find employment. It is here that the ideas of the inventor or designer assume their first tangible form. All machinery for the proper handling of guns and for furnishing ammunition to the same is designed at the Bureau of Ordnance, at the Navy Department or at the factory itself. Drawings from these designs are given to the patternmaker, who makes the wooden patterns from which castings of brass, iron or steel are taken.

The pattern shop, together with the other shops devoted to the manufacture of ordnance, is under the supervision of Capt. E. C. Pendleton, U. S. N., who is serving his second term as superintendent of the Naval Gun Factory. During his terms of office he has supervised some of the [illegible] important work needed to convert the old navy yard into the excellent plant our government now possesses. Capt. Pendleton is at present engaged in directing the installation of a new heating and power plant, which is to cost something like $750,000. Mr. M. A. Lynch is the foreman of a group of departments of which the pattern shop is one. Until about a year ago the pattern shop was under the immediate control of I. McKim Chase, a gentleman of national reputation as a patternmaker, and the author of "The Screw Propeller," "The Art of Patternmaking," and of numerous magazine articles. Mr. Chase was connected with the pattern department of the yard for thirty years prior to his death. Mr. B. M. Aitcheson is now the master patternmaker.

The pattern shop, situated in the southwest end of the yard, is a two-story brick building 250 feet long by 64 feet wide. It was entirely remodeled three years ago and is today pronounced to be one of the finest woodworking establishments in the country. The old machinery has been replaced by over seventy machines of the newest type and with the latest improvements. The first floor is occupied by joiners engaged in the manufacture of ammunition chests and boxes for holding shells of every size, wheels for field-gun carriages and limbers, file cases, sponge heads and handles, all kinds of cabinet work as desks and work benches, and indeed all varieties of machine woodwork. The second floor is used by the patternmakers. Fig. 5 is a view of the river from the windows, while Fig. 2 gives a view of the interior of this shop, showing the work benches on the right and the machinery on the left, also a number of unfinished patterns. It is here that the important work is performed. The benches, which are designed to accommodate two mechanics, are new, well made, and equipped with the latest Emmert vises. They are near the windows and run at right angles to them, thus affording ample light—one of the most necessary adjuncts of a pattern shop. The entire building is provided with the Sterling blower and pipe system by means of which all shavings, dust, etc., are forced by air through pipes leading from the benches and various machines to large receptacles outside the building. These large tanks, as they are called, are so arranged that carts can stop beneath them and the driver can, by pressing a lever, empty the contents into the carts. Fig. 4 shows some of the large pipes leading from the blowers, also a tank on the north side of the shop. For use on

Fig. 2. Interior View, showing one Floor of Pattern Building

cloudy days, or in the event of night work, a system of electric lights is installed on both floors. At each end of the building are elevators for the transportation of patterns, lumber, etc.

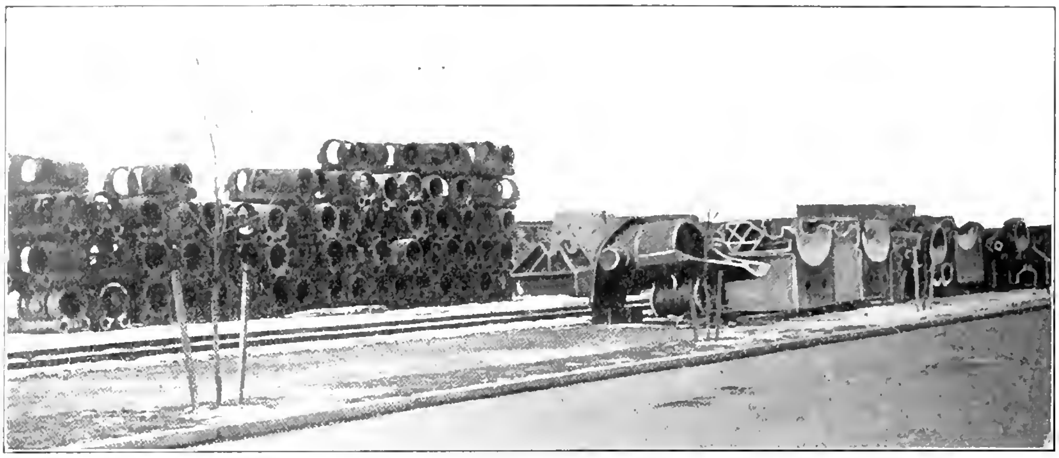


Fig. 3. Pile of Heavy Castings for Gun Mounts.

The pattern makers construct patterns for all the machinery used in manipulating the guns on board the ships of our navy, on the small torpedo boats as well as on the large battle-

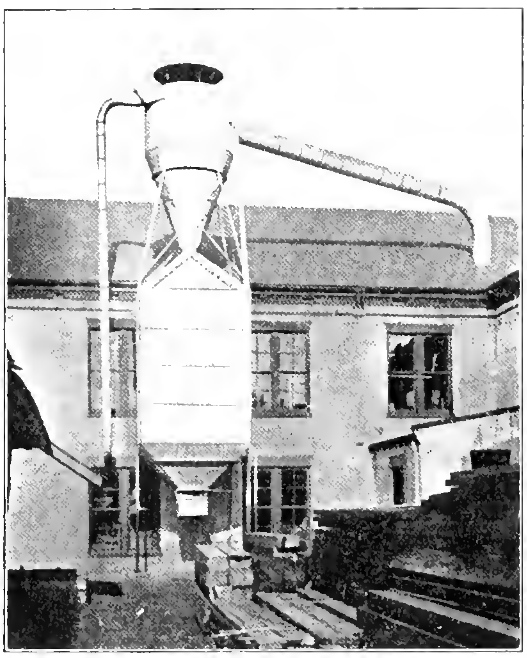


Fig. 4. Tank and Blower System for Gathering Shavings.

ships. In other words, patterns are made for the machinery required to mount the various size guns, for elevating and training them, and for loading devices by means of which the ammunition is brought in metal cars from the magazines of the ship to the breach of the guns; while patterns are also made for the different size shells, that is to say, for the ammunition itself. A group of castings is shown in Fig. 3 secured from patterns made in this shop and consisting of deck lugs, slides, and top carriages. A great deal of difficulty was encountered with the first steel casting made some years ago on account of the irregular shrinkage that occurred, but experience has corrected this and now there is very little complaint. Shrinkage scales provided by the government are used, and graduated to suit the various shrinkages. The scale is as follows: Iron, 1/8 inch to the foot; bronze, 15-100 inch to the foot; and manganese bronze and steel, 3-16 inch to the foot. Of course on large patterns the shrinkages have to be applied as experience shows to be best, as, for instance, in the construction of the pattern for the 8-inch deck lug shown in Fig. 6, where the shrinkage used was as follows: Length, 3-16 inch to the foot; width, 1/8 inch to the foot; height, 15-100 inch to the foot. The same shrinkages were allowed on the core box, except in the width, where only 5-200 inch was allowed. The castings secured from this pattern are estimated to weigh 5,335 pounds each, and form part of the mount for guns of this size on the U. S. S. *Virginia* and other ships of her class.

The patterns in this shop are made principally of white pine. Difficulty is encountered in securing well-seasoned lumber devoid of knots, hence in winter almost all the lumber used is subjected to a process of drying in the dry-kiln connected with the shop. Standard patterns of the smaller size, from which a large number of castings are required, are made of bay wood which, on account of its hardness, is very desirable for patterns that are often used. An example is: A pair of helical miter gears is used on the large 110-ton crane in the north gun shop of the yard. They are constructed of bay wood with the teeth made of cherry.

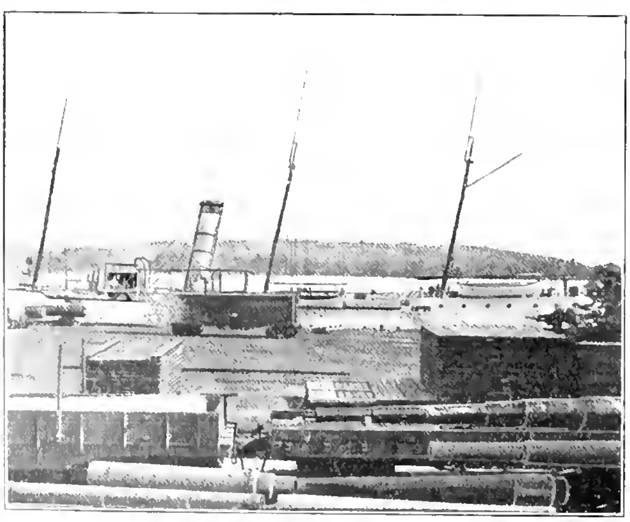


Fig. 5. View from Pattern Shop Window.

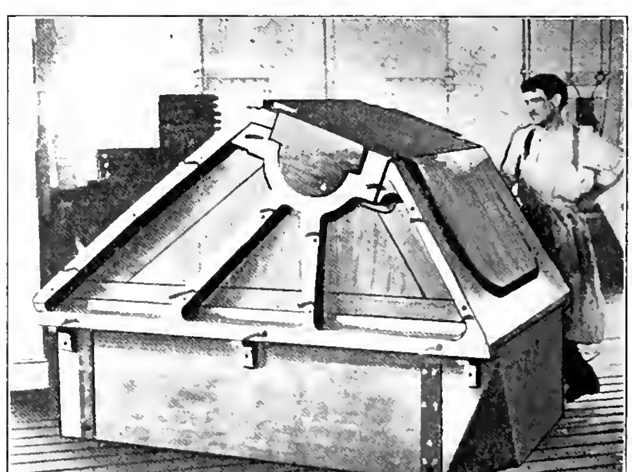


Fig. 6. Example of Pattern Work.

Each tooth is secured to the rim of the wheel by a dovetail which allows the tooth to be removed and worked off after being turned and laid off to the proper dimension on each end. Although their construction required some time, for they are a type of the costly pattern, it was an act of economy in the government to build a pair of these patterns for its own use, since patterns of this kind will, with good usage, last for a number of years.

Some idea of the amount of work done in this shop may be gained from the fact that over 1,500,000 feet of lumber are annually used in the pattern shop. A complete record is kept of all the patterns made. After being completed by the patternmaker, they are weighed and reported finished, and, after inspection by the officer in charge, are stenciled with name and number and sent to the foundry to be molded. The required number of castings having been secured, the patterns are sent to the pattern loft, a large building used for storing them. This building is now stored with a number of patterns whose value can be inferred when it is stated that the registered number of patterns is nearly 8,000, while in many cases months of labor were required for the construction of a single pattern. All patterns are given several coats of yellow shellac with core prints of black.

* * *

SOME REFINEMENT OF MECHANICAL SCIENCE.

In his address at the annual meeting of the A. S. M. E., held in New York last month, Mr. Ambrose Swasey, the retiring president, began by saying a few words concerning the growth and progress of the society since its organization. Continuing, he said, "I wish to speak of a few of those methods and mechanisms which have been developed and perfected to such a degree of refinement that they may be considered as almost beyond the practical, and yet were it not for such refinements they could not possibly be made to serve the utilitarian purposes which make them of such inestimable value to us all."

Mr. Swasey spoke first of the progress made in the accurate division and measurement of time, saying that before the christian era the length of the solar day had been fairly well defined, but it was not until 1582 that astronomers computed the exact length of the solar year, and with such precision did they then determine it that our present calendar will continue on for twenty thousand years, with an error not to exceed a single day. The device used for this calculation is still shown in the calendar room of the Vatican Observatory. In the center of the room, forming a part of the floor, is a large marble slab with a fine line cut exactly in the true meridian, and upon the line is a special mark indicating the altitude of the sun at noon of a certain day. On the south wall, near the top of the room, is a small aperture through which the direct rays of the sun pass at noon, projecting a bright spot on the meridian line. In this day of instruments such a simple device would hardly be thought of use, yet it served its purpose admirably and was considered one of the greatest scientific achievements of that age.

Since an unknown time the day has been divided into twenty-four hours, measured in turn by the sun-dial, the hour glass, the water clock, and from the twelfth century on, by clocks of the present type. The first water clocks used by the Greeks consisted of two jars so arranged that the water from the upper ran into the lower, and the time of day was determined by measuring the water remaining in the upper jar. To this day water clocks are used extensively in the East, and in the city of Canton even the standard time is kept by an improved water clock which has been running for eight hundred years, and which, notwithstanding its long service, shows no perceptible wear. This improved clock consists of four jars placed one above the other, and the hour is shown by the position, in reference to a cross bar, of a graduated upright attached to a float in the lowest jar.

Galileo's discovery of the isochronism of the pendulum was of great value in many respects, but in none more so than in its application to the measurement of time. Soon after that great discovery, the English clockmaker, Graham, invented the mercurial pendulum by which the variation in length due to temperature was compensated, and a few years later Harrison, another English clockmaker, invented a compensating pendulum consisting of a series of metal bars having different coefficients of expansion. Since that time every part of the clock has been the subject of study and improvement, and they are now made with such precision and delicacy that in testing them the question is, within how small a fraction of a second will they run. Some of the finest astronomical clocks are inclosed in glass or metal cases in which a partial vacuum is maintained, wound automatically by electricity, and set up in underground vaults so that errors due to vibration, change of temperature or barometric conditions are made practically impossible. A clock installed at the Observatory of Case School of Applied Science at Cleveland, running under these favorable conditions, has a mean error of fifteen one-thousandths of a second per day, and a maximum error for several months of but twenty-two one-thousandths of a second per day. This is a notable example of the present state of the art of clock-making and shows the wonderful precision with which minute intervals of time can be measured. From the time of the invention of Peter Hele, in 1477, of the "Nuremburg Animated Egg" or "pocket clock," which required winding twice a day and varied an hour and a half in the same length of time, the development of the watch has kept pace with the "Mother Clock."

The larger watch, or ship chronometer, with its escapement so delicately made and adjusted that it must always be kept in the same position, was greatly improved through the efforts of the British Government in 1714 by offering rewards of ten, fifteen and twenty thousand pounds to any who should make chronometers that would run so accurately that the longitude of a ship at sea could be determined within sixty, forty and thirty miles; and Harrison, the inventor of the compensating pendulum and the compensating balance, which is now used in watches, succeeded in making a chronometer, which, after being tested on a long voyage, was found to run so closely that the position of the ship was determined within eighteen miles, and he was therefore paid the full award of twenty thousand pounds. That historic chronometer, which marked a new era in navigation, is now numbered among the treasures of the Greenwich Observatory.

Modern ships are equipped with chronometers so accurate and so reliable, and with sextants of such precision that navigators can determine their position in latitude and longitude within a few miles. Therefore, with the increased speed of the powerful ships carrying hundreds or even thousands of passengers, together with their valuable cargoes, the methods and instruments used in navigation have been so improved as to greatly diminish the dangers in crossing the seas.

The perfection attained in the measurement of time, which is of such great practical value in nearly every sphere of life would not have been possible were it not for the even greater refinements that have characterized the methods and instruments used by the astronomer in determining the length of the day and of the year, which are the fundamental standards of time.

After saying substantially the above Mr. Swasey continued his address as follows:

"The division of the circle and the measurement of angles have ever been among the unsolved problems of the astronomer, yet in the instruments used by him, circles have formed a most important part.

Long before the telescope was invented, Tycho Brahe, the Danish astronomer "the founder of Modern Astronomy," constructed for his observatory, instruments of various kinds having graduated circles and arcs of circles. His instruments for the most part were improvements on those used by Arabian astronomers in the eighth and ninth centuries, and these in turn, were copied after similar instruments used by the Greeks and Egyptians, a thousand years previous, and it is supposed that such instruments were used by the Chinese at an even earlier period, so that graduated circles have come down to us from the far off ages.

The longer the radius the more accurate the graduations was the principle upon which the early instruments were

made. The Arabians, in about the year 1000, built a sextant with a sixty-foot radius and a quadrant with a twenty-one-foot radius, but to Tycho Brahe is due the credit of constructing instruments having circles, much smaller in diameter and graduated with a greater precision than ever before. It was by the use of such improved instruments of his own making, and by his observations which were made without a telescope or any means of magnification, that he was able to give the positions of a large number of stars within less than one minute of arc from the positions given by modern astronomers.

The first circular dividing engine was made in 1740 by Henry Hindley, of New York, for cutting the teeth of clock wheels, and it is interesting to note that in the same year Huntsmann, another clockmaker, of Sheffield, invented the process of making crucible steel, that he might have a metal suitable for the springs of his clocks.

Of the several engines constructed later, the one most successful and representing the greatest progress, was that made by Ramsden, in 1777. This engine, automatic in its movements, was made especially for graduating circles, and because of the great precision with which he divided the circles of the instruments used by the Government, the Board of Longitude awarded him the sum of six hundred and fifteen pounds.

In a dividing engine the chief essential is that the spindle carrying the master-plate shall be as nearly round and as closely fitted in its bearings as is possible, for the degree of excellence with which that work is done determines how closely a circle can be divided.

It seems almost incredible that a well-lubricated spindle of four inches in diameter at its largest part and tapering three-quarters of an inch to the foot, can be made so nearly round and so closely fitted in its bearings that a movement of one-thousandth of an inch in or out of its bearings, will in one case cause it to turn with difficulty, and in the other with perfect freedom; yet this has been found to be within the limits of mechanical refinements.

The greatest accuracy thus far attained in such engines, is one second of arc, which arc, with a radius of three miles equals one inch, and at twenty inches, which is the radius of the silver ring upon which the graduations on the master-plate are made, a line one-thousandth of an inch in width is equal to twelve seconds of arc, or twelve times the accumulated errors of any number of divisions, or twenty times the greatest error of any single division.

In automatically graduating a circle, it has been found to be impracticable to cut more than six lines in a minute, and it requires about thirty-three hours to divide a circle into two-minute spaces. As with the running of the finest clocks; the best results can only be obtained when the engine is surrounded with every favorable condition possible. Instead of the large circles and sectors used by the ancients, they have been made smaller in diameter as the methods for graduating have been improved, until those of the more modern instruments are seldom more than thirty inches, and some of the latest meridian instruments have circles of but twenty-five inches.

The smaller circles, which can be made and graduated with greater precision than the larger ones, are also less liable to change in form, owing to their weight and the variation in temperature, and with the aid of the reading microscope the results obtained would not be possible with the larger circles. A twenty-five-inch circle read with a microscope having a power of forty, would be equivalent to a circle of about eighty feet in diameter, and a single second of arc as seen through the microscope would be equal to 0.0024 of an inch, a quantity easily subdivided.

The cross wires, which are but common spider lines, because of their fineness and the remarkable qualities they possess, are indispensable in micrometric work.

That the repulsive and even dangerous spider has plenty of enemies among the human family, there can be no doubt, yet if the value of the contributions which it has made to the cause of science were generally known, it would surely have a greater number of friends than at present, and most certainly the astronomer will say naught against it, for after the experience of many years he has found that the spider furnishes the only thread which can be successfully used for the cross wires of his instruments.

The spider lines mostly used are from one-fifth to one-seventh of a thousandth of an inch in diameter, and in addition to their strength and elasticity, they have the peculiar property of withstanding great changes of temperature, and often when measuring the sun spots although the heat is so intense as to crack the lenses of the micrometer eye-piece, yet the spider lines are not in the least injured. The threads of the silk-worm, although of great value as a commercial product, are so coarse and rough compared with the silk of the spider that they cannot be used in such instruments. Platinum wires are made sufficiently fine, and make most excellent cross wires for instruments where low magnifying powers are used, yet as the power increases they become rough and imperfect.

Spider lines, although of but a fraction of a thousandth of an inch in diameter, are made up of several thousands of microscopic streams of fluid, which unite and form a single line, and it is because of this that they remain true and round under the highest magnifying power. An instance of the durability of the spider lines is found at the Allegheny Observatory, where the same set of lines in the micrometer of the transit instrument has been in use since 1859.

In the realm of the measurements of minute linear distances, and the perfection of curved and flat surfaces, the refinements are even greater than those pertaining to the measurement of time and of angles. Most important in the linear dividing engine is the screw, and although much had been accomplished in bringing such engines to a high degree of excellence, it was for Prof. Rowland to make an engine which has a practically perfect screw; and without doubt it is in all respects the nearest perfect of all the mechanisms that have been employed for ruling lines exactly parallel and equally spaced.

The Rowland engine was made especially for ruling diffraction gratings which are made of speculum metal, and with it a metal surface has been ruled with 160,000 lines, there being about 29,000 to the inch, and as many as 43,000 lines to the inch have been ruled. The gratings mostly used have from 14,000 to 20,000 lines to the inch, and with such exactness is the cutting tool moved by the screw that the greatest error in the ruling does not exceed one millionth of an inch.

The production of these gratings, which has enabled the physicist in his study of the spectrum to enter fields of research before unknown, has not only called for the highest degree of perfection ever attained in the spacing of linear distances, but it has also called for a refinement most difficult in the optical surfaces upon which the lines are ruled. To Mr. Brashear was given the problem of producing such surfaces, and notwithstanding the many difficulties encountered in working and refining the speculum metal plates, he has made many hundred plates with surfaces either flat or curved with an error not to exceed one-tenth of a wave length of light, or one-four-hundred-thousandth of an inch.

The established standards of length which are the yard of Great Britain and the meter of France, being made of metal, and liable to destruction or damage, Prof. Michelson conceived the idea of determining the lengths of these standards in wave lengths of light, which would be a basis of value unalterable and indestructible. For the purpose of carrying out these experiments, the interferometer was constructed, an instrument which required the highest order of workmanship and the greatest skill of the optician. Again Mr. Brashear proved to be equal to the occasion, and made for the instrument a series of refracting plates, the surfaces of which were flat within one-twentieth of a wave length of light, with sides parallel within one second. This was the most difficult work ever attempted in the refinement of optical surfaces.

Professors Michelson and Morley devised a method for using the interferometer for making the wave length of some definite light an actual and practical standard of length. So satisfactory was the result that Prof. Michelson was invited to continue the experiments at the Bureau of Weights and Measures, at Sèvres, France, where the standard meter, which is kept in an underground vault and inspected only at long

intervals, was used for that important work, which occupied nearly a year. The final result of the experiments shows that there are 1,553,164.5 wave lengths of red cadmium light in the French standard meter, at 15 degrees Centigrade. So great is the accuracy of these experiments, that they can be repeated within one part in two millions. Should the material standard of length be damaged or destroyed, the standard wave length of light will remain unaltered, as a basis from which an exact duplicate of the original standard can be made. These two marvelous instruments, the Rowland dividing engine and the Michelson interferometer, show the possibilities in the perfection of linear divisions and the standards of length.

* * *

CONTEMPORARY TECHNICAL EDUCATION.*

The young man who is to follow a narrow routine through life will not have added much to his efficiency, as a machinist, by the long elaborate course of the technical school. For those constitutionally deficient in ambition, or for those unfortunates who can never comprehend the art of getting on in the world, these four extra years are ill spent at school, but there are plenty of young men for whom this training of the technical school is the best possible training, and there is plenty of opportunity for a larger number of these men than all of our present schools can graduate.

Men cannot be shaped on the interchangeable system of the American machine shop; each will be a "special," and, as already remarked, there will be produced "firsts," "seconds," and "thirds," but fortunately the demands for all types and grades exceeds the possible supply for years to come. Among the graduates some will possess that rare faculty for which "initiative" is the phrase of the day, and among these there will be some who will possess that quality of balance and judgment, and attain such knowledge of men, that they will become great leaders—the captains—will establish their own industrial works or be called to the $10,000 positions which are always so hard to fill right. Others, without this business insight, but perhaps more learned and more skillful in engineering, will design machines and bridges, supervise factories, become the lieutenants and fill the $4,000 and $2,000 positions, and still a larger number will do noble work as the sergeants, corporals and privates and be made better men by the broadening of their minds.

The training of no school can make the square peg fit easy in the round hole, and, out of a hundred boys, but few are born with the ear of a musician or the eye of an artist, or with the observing, inquiring, ingenious, imaginative mind which schools can stimulate but cannot create, and without which conspicuous success in constructive engineering is impossible. But for the young man so fitted by nature, a technical school of broad scope and high aim is a royal road. The old statement that "There is no royal road to learning" is untrue. The man of affairs has come to understand that the technical school is a royal road to learning, a shorter road, an easier road, through a more beautiful landscape, and in equal time attaining a broader outlook.

A man with the earnestness and patience of John Brashier, the strong purpose of John C. Hoadley, the rugged common sense of Edwin Reynolds, the strong, kindly heart and quick intelligence of John Fritz, or the genius of Edison, may reach an equal height by a longer and more arduous road, and, like the athlete, increase his strength and harden his endurance in the greater effort, but the royal road of the technical school, in its four years, may, from its small group, gathered part by chance and part by process of natural selection from more than ten thousand school boys, bring perhaps ten to the point that otherwise not more than one or two or three could hope to reach in twice these four years.

* * *

FIRE PROTECTION IN MARSHALL FIELD DEPARTMENT STORE, CHICAGO.

The value of private fire apparatus for the protection of individual buildings and adjoining property was thoroughly demonstrated in the Baltimore and Toronto fires, and, in fact, the Baltimore fire department admits that many buildings on the immediate margin of the devastated tract were saved only by the effective work of private apparatus. These buildings were supplied with either standpipes or pumps connected with wet-pipe interior sprinklers and dry-pipe sprinklers for protection from outside fires, storage tanks holding from 1,500 to 15,000 gallons being placed on the roofs. Besides saving the buildings in which they were located these equipments stopped the advance of the fire, and undoubtedly many more buildings would have been destroyed in the absence of their efficient service. The buildings and contents protected by private apparatus in Baltimore were valued at five million dollars and at Toronto the saving from private protection was similar in extent.

The fact that such apparatus is on the ground, in position and ready for action averts the destruction of much property by both fire and water. A fire is usually well under way before the city fire companies can arrive, arrange their hose lines and make necessary couplings and connections. A drenching of the entire building is then often required, while a comparatively small amount of water would have put out the fire in the first place. The immediate availability of private fire apparatus gives it a great advantage over any other form and has long been employed by manufacturing concerns. Such apparatus usually consists of direct-acting pumps, steam-driven. A large installation of the kind, however, in one of the largest department stores is of interest because it is electrically-driven and seems to meet the needs of independent apparatus for office buildings and other structures in cities. An important consideration in selecting an apparatus of this sort is the readiness with which electric power can be obtained and utilized; there being hardly a building where a reliable supply of electric current cannot be cheaply and easily obtained. There is, further, no maintenance expense as with steam apparatus.

The installation referred to is in Marshall Field's immense department store, Chicago. The outfit consists of a Laidlaw-Dunn-Gordon duplex underwriter pump connected by single-reduction gearing to a water-proof electric motor. The pump cylinders are eight inches in diameter by twelve inches stroke, having a theoretical capacity of 700 gallons per minute at 600 R. P. M. against 140 pounds water pressure. There are large pressure and vacuum chambers, required by the underwriters' specifications. The pump is thoroughly rust proof in all moving or wearing parts, insuring prompt and smooth running when occasion arises.

The motor, which was furnished by the Chicago Edison Co., is shunt-wound for 220 R. P. M. at 230 volts and is inclosed, all connections being carried through pipes screwed into the frame, so that the device may be flooded without affecting its action. The fields and armature coils are cooled by fans on the armature shaft.

* * *

THE PANAMA CANAL PROBLEM.

The Panama Canal is likely to be a very costly undertaking for the United States Government, and the time of its building will probably be equal to that of a generation, if present estimates are right. Chief Engineer Wallace, of the Isthmian Canal Commission, has reported that a sea level waterway across the Isthmus, although it would cost far more and take much longer to complete than the three other canal projects under consideration, would in the end be the best. In his opinion the cost of the sea level canal would be $300,000,000, as against $200,000,000 for a 90 foot level canal, and he thinks that twenty years would elapse before its completion, or ten years more than for a canal with locks. Here apparently is a great opportunity for the development of machinery that shall make as great an advance in such work as was done on the Chicago Drainage Canal. It is imperative that the time of construction be reduced; every year that its completion is delayed means, in effect, greatly increased cost of construction when the loss to commerce is taken into account. It is a chance to put to use on an enormous scale the knowledge gained in hydraulic placer mining in the West. Both the loosening and transportation of the material to the sea might be accomplished rapidly in this manner.

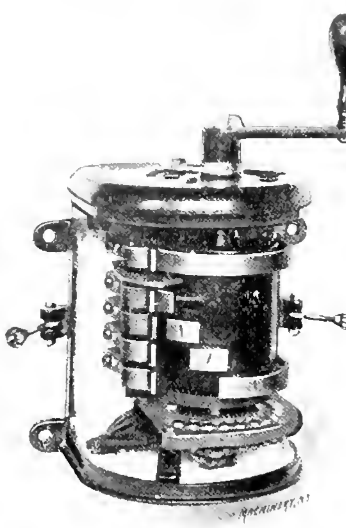
* Extract from an address by Mr. John R. Freeman at the Case School of Applied Science, May 11, 1904.

VARIABLE SPEED MOTORS.—9.

THE CUTLER-HAMMER VARIABLE-SPEED CONTROLLERS

WM. BAXTER, JR.

The Cutler-Hammer Mfg. Co., of Milwaukee, make a number of designs of controllers for variable-speed motors, some of which are of the drum type while others are of the slate front, or clock dial type. To describe all these designs would require too much space, but as many of them are but slight modifications of others, the description of a few, each one typical of its class, will serve to give a fair idea of their



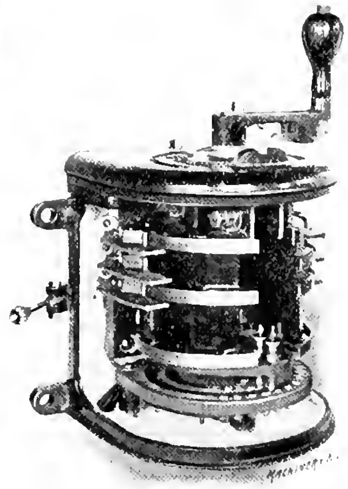


Fig. 1. Controller, Non-reversing Type. Fig. 2. Controller, Reversing Type.

construction and operation. These controllers are used in connection with many different designs of motors made by concerns that do not manufacture their own controllers.

Fig. 1 shows a non-reversing drum controller with the casing removed. A diagram showing the various contacts of this controller and their connections with each other, with the motor and the supply wires, is given in Fig. 4. Fig. 2

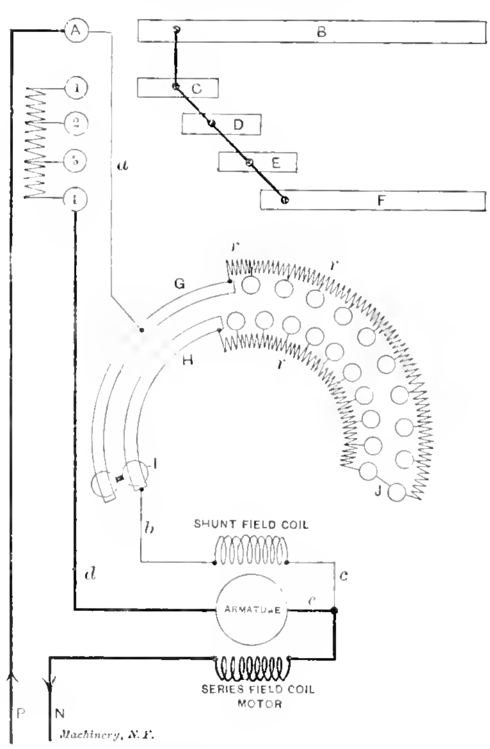


Fig. 4. Diagram of Controller, Fig. 1.

shows a reversing controller of the drum type, and a diagrammatic representation of the contacts and connections is given in Fig. 5. Fig. 3 shows a slate front controller of the reversing type. The development of this controller is shown in Fig. 6.

In these three controllers the speed variations of the motor are effected by introducing resistance in the shunt field circuit, that is, by field regulation.

Construction and Operation of the Non-reversing Drum Controller.

The diagram, Fig. 4, illustrates the arrangement of the contacts and circuit connections of the non-reversing drum controller. In this diagram the motor, which is represented as of the compound-wound type, is located at the bottom and the parts above it are the controller. The circles *A*, 1, 2, 3, 4, are stationary contacts that press upon rings *B C D E F*, mounted on the drum. These contacts and rings are clearly shown in Fig. 1. The drum rings *B C D E F* are electrically connected with each other. When the drum is turned to the first position, *B* and *C* make contact with *A* and 1, and then the line current from *P* passes from *A* to *B* thence to *C* and to 1. The armature starting resistance is connected, as shown, between the stationary contacts 1, 2, 3, 4, hence when only *A* and 1 are connected with the drum rings, as is the case in the first position, the current must pass through all the starting resistance to reach wire *d*, and thus the armature. From the armature through wire *e* the current passes to the series field coil of the motor and thence to line wire *N*. The

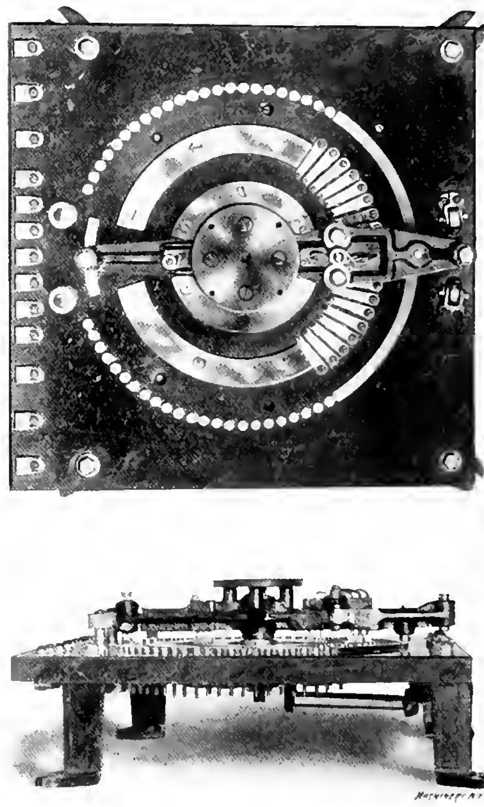


Fig. 3. Controller, Slate Front, Reversing Type.

current for the shunt field starts from *A* through wire *a* to segment *G*, thence through the sliding contacts *I* to *H* and by wire *b* to the field coil, from which it passes through wire *c* to *e*.

The further rotation of the controller cylinder causes the rings *D E* and *F* to come in contact with 2, 3 and 4 one after the other, and thus the starting resistance is cut out of the armature circuit in three sections.

The segments *G* and *H* and the circular contacts following them are stationary and are located at the bottom of the controller, as clearly seen in Fig. 1. The sliding contacts *I*, which are electrically connected with each other, are carried by the cylinder, and slide over *G H* and the small contacts as the cylinder advances. While the cylinder is advancing to cut out the starting resistance, *I* slides over *G* and *H* and reaches the ends near the circular contacts, by the time *F* connects with 4. If the controller is left in this position, the motor will run at its lowest speed. If a higher speed is desired, the controller handle is advanced and then *I* slides over the circular contacts and cuts into the shunt field coil circuit more or less of the resistances *r r r*. When the controller handle is rotated as far as it will go the sliding contact *I*

will rest on the end contacts J and all the resistances $r\ r\ r\ r$ will be cut into the field circuit and the motor will be running at its highest velocity. Any speed between the high and the low can be obtained by moving the controller handle until I rests at the proper point. As the field resistance $r\ r\ r$ is divided into many sections and these can be cut out one at a time, many different speeds can be obtained.

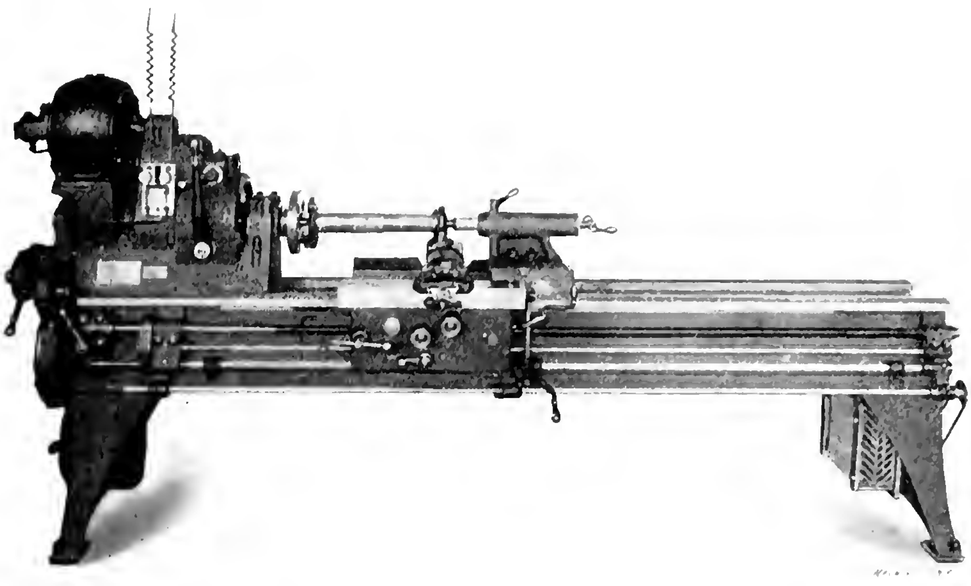


Fig. 7. "Northern" Variable-speed Motor, operating Springfield Lathe, with Cutler-Hammer Slate Front Controller.

The Reversing Type of Drum Controller.

The arrangement of the contacts and connections of drum controller of the reversing type is shown in Fig. 5. As in Fig. 4, the motor is located at the bottom of the diagram, and is of the simple shunt type. The controller can be used with a compound wound motor, however, by simply connecting the series field in either one of the wires P or N, but not in the armature wires 7 and 8, for in the latter position the reversal of the current through the armature would also reverse it through the series field coil, and thus make the motor of the cumulative type for one direction of rotation, and of the differential type for the opposite direction.

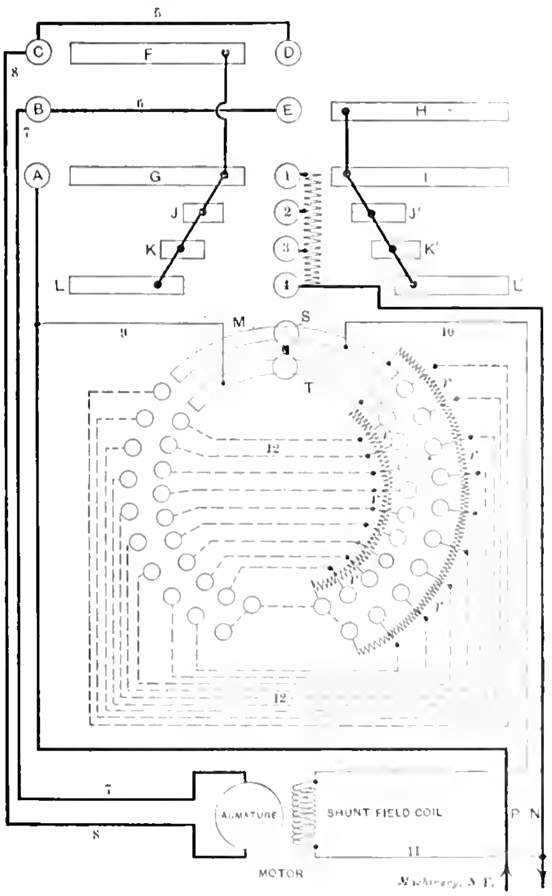


Fig. 5. Diagram of Controller, Fig. 2.

In the reversing controller there are two sets of stationary contacts, one located at the center of the diagram and marked $D\ E$ 1, 2, 3, 4, and the other located at the left of the diagram and marked $A\ B\ C$. In Fig. 2 these two sets of contacts can be seen one on each side of the cylinder. In Fig. 5, if the cylinder is rotated so as to move to the left, rings F and G will connect with C and A respectively, and rings H and I will connect with E and 1. With these connections, the current from P will pass to A, thence to G to F to D through wire 5 to C and wire 8 to the motor armature. Returning from the armature through wire 7 to contact B and wire 6 to contact E the current reaches contact 1 through the drum rings H and I. From 1 the current passes through the starting resistance connected between contacts 2, 3, 4 and thus reaches the line wire N. The shunt field current branches from P through wire 9 to segment T, and through the sliding contacts S to M thence through wire 10 to the field coil, and from the latter through wire 11 to line N.

The rings located at the lower end of the drum are arranged the same as those in Fig. 1, but are in duplicate so as to cut out the starting resistance whichever way the cylinder may be turned. The segments M and T and the circular contacts in line with them are stationary and are located at the bottom of the controller as shown in Fig. 2, and the sliding contacts S which are electrically connected with each other are carried by the cylinder. As with the non-reversing controller, the contacts S do not pass off segments M and T until after ring L, or L', has made contact with 4. The further rotation of the controller handle carries S over the circular contacts and cuts into the shunt field coil circuit more or

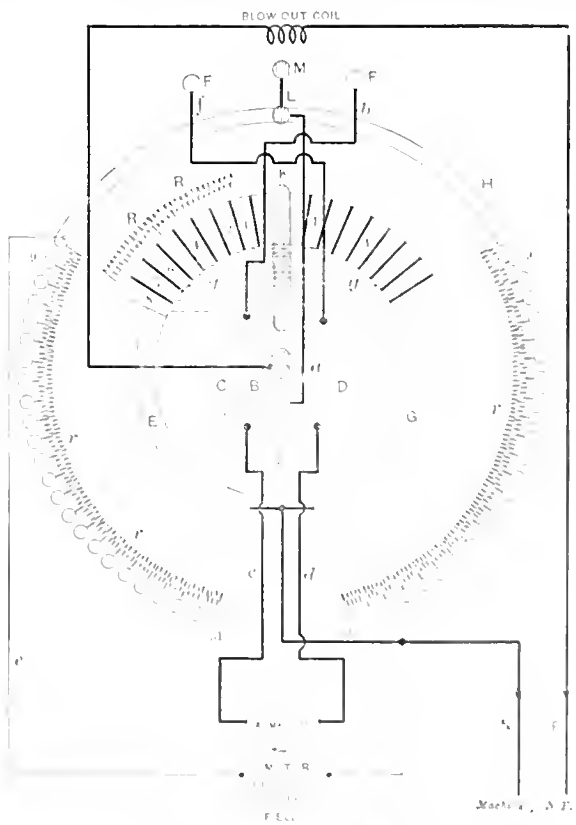


Fig. 6. Diagram of Controller, Fig. 3.

less of the regulating resistance $r\ r\ r$ according to the distance through which S is carried, the action being the same as in Fig. 4.

To reverse the direction of rotation of the motor, all that is necessary is to reverse the direction of the current through

the armature; in other words, the current from line wire P must enter the armature through wire 7 instead of through wire 8. If the controller handle is turned so as to carry the cylinder rings to the right, then rings F and G will connect with stationary contacts D and 1, respectively, and rings H and I will connect with B and A. With these connections it will be seen that the current from line wire P will pass through A to I and thence to H and to B and through wire 7 to the armature, returning from the latter through wire 8 to C to 5 to D to F to G to 1 and through the starting resistance to line wire N.

As the sliding contacts S rotate in one direction for the forward motion of the motor, and in the opposite direction for the reverse motion, the segments M and T are located in a central position and with circular contacts at each end, so that whichever way S may move it will cut in and out in the proper manner the field resistance r r r r. In these drum type controllers, as a rule, the resistances are not made a part of the controller, but form a separate structure, and for that reason the contacts on opposite sides of segments M and T are connected with each other in the manner indicated by the broken lines 12.

Arrangement of the Contacts and Connections and Operation of the Slate Front Controller.

The diagram, Fig. 6, shows the arrangement and connection of the contacts of the slate front controller illustrated in Fig. 3. The switch lever carries the connecting contacts J K L and M. Of these contacts K is isolated, but J L and M are connected with each other, as shown by wire a. The center stud B, on which the lever swings, is connected with line wire P. The two segments E and G are connected with line wire N. The contacts 8 8 are connected with E and with G, but the remaining contacts in this circle, that is, 1, 2, 3, 4, 5, 6, 7, are insulated from each other and the only connection between

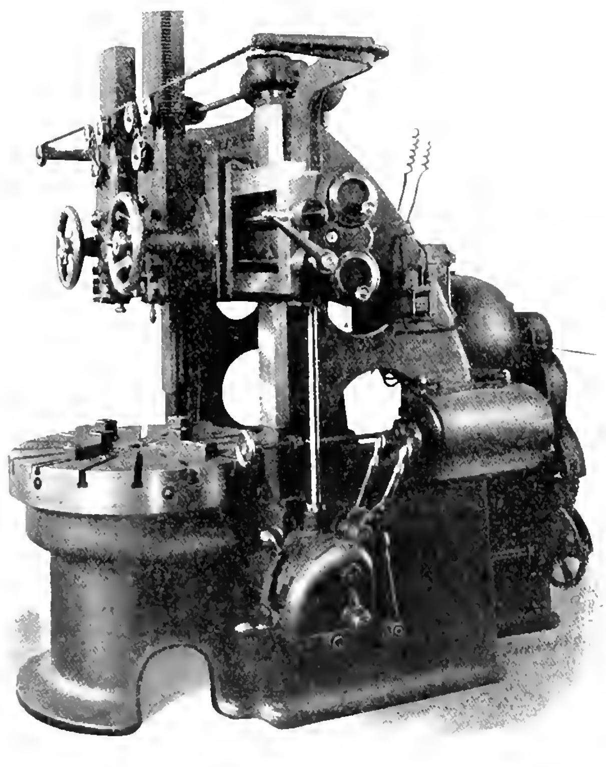


Fig. 8. "Northern" Motor operating Gisholt Boring Mill, with Cutler-Hammer Gear-driven Drum Controller.

them is through the armature starting resistance R. One end of the shunt field circuit is connected with segment H and the other with line wire N.

If the switch lever is turned clockwise, the current from wire P after reaching B will pass through J to C and thence by wire c to the motor armature, returning to D through wire d. From D through K the current will pass to 1 and thence, through the connection shown in broken lines g, to the left side of the controller, and through the starting resistance R to segment E and to line wire N. The field coil current will start from J through wire a to contact L and to H, thence through wire e to the field coil, and from the latter to wire N.

As the switch lever is advanced, K will pass over the contacts 2, 3, 4, etc., to 8, and thus cut out the starting resistance. If the switch lever is left with K resting on 8, the motor will run at the lowest velocity, but if it is advanced until L rests on 31 the speed will become the maximum, as then all the field regulating resistance r will be cut into the circuit.

If it is desired to run the motor in the opposite direction, the switch lever is turned counter-clockwise, and then the current from wire P will pass from B through J to D and thence through wire d to the armature, passing through the

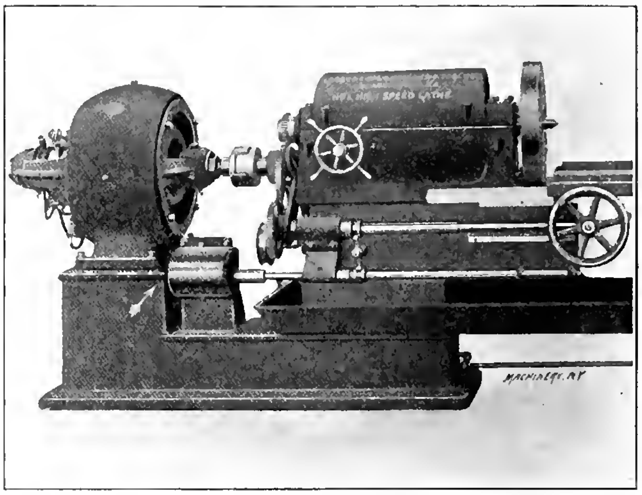


Fig. 9. Lodge & Shipley Lathe operated by "Northern" Motor, with Cutler-Hammer Direct-driven Drum Controller.

latter in the opposite direction. From the armature the current will return through wire c and reaching segment C will pass through K to the contacts 1 2 3—8 to E and to line wire N.

At F F are located contacts the purpose of which is to prevent sparking between J and C, or D, when the motor is stopped. As will be seen, the circuits would be complete if the contacts F F and the wires b and f were removed, but in returning to the stop position, J would separate from C or D—whichever one it happened to be in contact with—and a heavy spark would be produced at the point of separation. With F F and wires b f added, when J breaks contact with C or D, the circuit is still kept closed because at that instant the contact M is resting on one of the F contacts. After J has broken contact with C or D, M separates from F and thus the circuit is opened at this point, and it is here that the sparking occurs. These isolated contacts can be made large so as to stand heavy sparking without serious injury; but for the purpose of reducing the spark as much as possible, a blow-out coil is located so as to blow out the spark when M separates from either one of the F contacts.

The contacts 9—31 on either side of the circle are not connected with each other in the manner indicated in Fig. 5, because in this type of controller it is more advantageous from a mechanical standpoint to provide a double set of field resistances r r. The starting resistance R is not made in duplicate as it is more desirable in this instance to cross-connect contacts 1, 2—8 as shown by the broken lines g.

A slate front controller of the type above described is shown in Fig. 7 mounted on an "Ideal" Springfield lathe, which is driven by a Northern variable speed motor. The controller is placed under the lathe bed at the tailstock end, and is operated by means of a shaft running along the side of the bed under the carriage, in a manner that is clearly shown.

Fig. 8 shows a drum type controller mounted on a Gisholt boring mill driven by a Northern variable speed motor.

Fig. 9 shows a Lodge & Shipley lathe with Cutler-Hammer direct-driven drum controller, driven by a Northern variable speed motor.

* * *

It is reported that the Southern Pacific Railroad Company are experimenting with an internal combustion locomotive built on the Diesel principle.

ELECTRIC REPAIRING.

ARMATURE WINDING.

NORMAN G. MEADE.

The repair shop of a manufacturing plant or electric railway plant should have at hand suitable stands or "horses" for holding armatures during the winding process. If the armature is small, short stands may be mounted on a work-bench.

When an armature comes in to be repaired, carefully caliper its diameter outside of the bands and the winding. Observe particularly the shape of the ends. As the workman proceeds to tear apart the armature, he should note the size of wire, style of winding, number of coils, convolutions per coil, number of layers, style of winding, etc. All such data

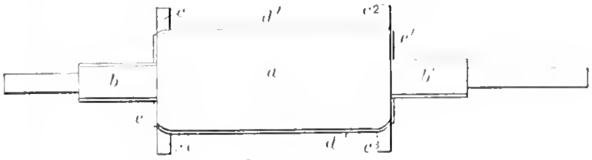


Fig. 1

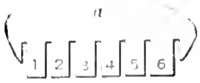
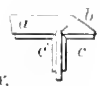


Fig. 2

Fig. 3



Machinery, N.Y.

Fig. 4

should enter a notebook, as this information will be of future value. It is well to head the entry with the name of the machine, horse-power, voltage and current, speed and serial number of the armature.

The first step in unwinding an armature is to unsolder the leads and remove the commutator. Then cut off the bands and remove the wire. If the coils are of the formed type, laid in slots, raise the upper half around the entire circumference, and remove the coils, in the reverse order to that in which they were put in. After the core is entirely stripped of winding and insulation, it is ready to re-insulate.

Fig. 1 is a sectional view of a smooth-core drum armature insulated ready for winding. In the figure, a is the bore; b and b' the ends of shaft covered as shown; c^1, c^2, c^3 and c^4 are fiber pegs for separating the coils; d and d' insulation on core, and e and e' insulating end disks.

Fig. 2 shows the manner of notching the core-insulation to

Fig. 9.

fit between the fiber pegs. Flexible micanite 1-32 inch in thickness, and held in place temporarily by a few turns of "flax," forms an excellent insulation. A ring armature, partially in section, is shown in Fig. 3. The shaft, a, pressed into the hub, d, carries the spider, to which is attached the ring, b. One wing of the spider is shown at c. A flexible micanite insulation, e, covering the outside, inside and ends of ring, is held in place by a tight wrapping of cotton tape, as shown at g. The wings of the spider must be insulated. This can be done conveniently, as shown in Fig. 4, which shows a sectional end view of an armature, a being the armature ring, b the spider wing, and c and c' triangular-shaped pieces of micanite extending the length of the wing. The triangular pieces are retained in position by the wrapping of cotton tape.

A section of a slotted armature is shown in Fig. 5. Here a is the end in section; b and b' are slots not yet insulated; c is a hard-wood or fiber block the length of the slot and slightly narrower; d is micanite insulation driven in place by the block, c; e is a slot insulated ready for the coil; f and f' are armature coils; h is the insulation between the coils; and i and i' the slot insulation trimmed flush with core a. The micanite is cut into strips of the required size, and folded over the block, c, to form troughs, as shown.

Another form of slot coming generally into use is shown in Fig. 6, in which a is the end of armature; b and b' V-shaped slots cut for receiving the wood retaining-strip, c; e and e' coils in the slot, with insulation, d, between them.

Fig. 7 is an end view of an armature partially in section. This view illustrates the winding process with a form of coil in common use. In the figure, a is the shaft; b the end of the armature; c, a piece of sheet brass the length of the slot and about 4 inches wide; 1, 2, 3, 4, 5, 6, 7 and 8 show the coils with one-half free and one-half in slots; 9, 10, 11, 12, 13, 14, 15 and 16 show one-half of the coil in cross-section. Proceeding to wind an armature of the type shown in Fig. 7, the first process is to insulate the slots in the manner already described, then drive one-half of the coil into place, continuing around the armature, thus filling half of each slot. The armature will then appear as shown. Fig. 8 is a piece of vulcanized fiber, shaped for driving coils into slots. In a four-pole ma-

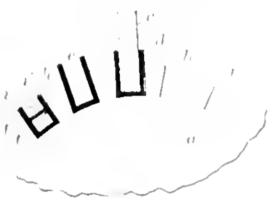


Fig. 5

Fig. 6

Fig. 7

Fig. 8

chine each coil will have a pitch of 90 degrees, that is, it will cover one-fourth of the periphery of the armature. The coils slip into the slots easily, with the exception of those on the last quarter. Beginning at a point three-fourths of the distance around the armature from the first coil, the outer half of the coils that have been laid in, will lap over the empty slots. At this point a little more labor is involved in getting the coils into their respective places.

Having completed the first process, start at any point to drive the outer half of the coils into slots. Hold the piece of brass, c, before referred to, in the left hand and slip it into the position shown. In this way it guides the coil 8 into the slot. With a mallet and the tool shown in Fig. 8 drive the coil snugly into place. Continue with each coil in like manner until all have been driven into their proper positions.

In Fig. 9, the periphery of the armature, A, is supposed to be laid out flat. In the figure, a, b and c are coils of the oblong type, which form a chordal winding. It will be seen that the coils are staggered, that is, the projecting ends alternate backward and forward. With this style of winding, the ends of the armature core must be well insulated. The coils, if not pounded into shape with a mallet, will interfere at d, e, f, g, h, i, j and k. The coil, a, extends from slots 1 to 6; b from 2 to 7, and c from 3 to 8. No specific directions can be given here for shaping these coils, as no two makes of armatures

are alike. By noting carefully the shape of the original coil, it will be an easy matter to form the new one. The winding is executed in a manner similar to the formed-coil winding previously described.

Taking up the subject of smooth-core drum armatures, let us study Figs. 10 to 15 inclusive, which illustrate some common types of winding. Starting with Fig. 10, we will assume each coil, for the sake of simplicity, to be one layer deep and three convolutions in width. Stand facing the commutator end of the armature, and tie the end of wire a to the fiber peg. Pass the wire downward over the end of the armature core and between the two pegs, diametrically opposite to the starting point. Turn the armature over and draw the wire tightly along its surface to the back end. Carry the wire around the shaft, on the side opposite to that followed on the front end, and through the pegs back to the starting point, having in the meantime turned the armature over to its original position. It is convenient to have the reel of wire suspended over

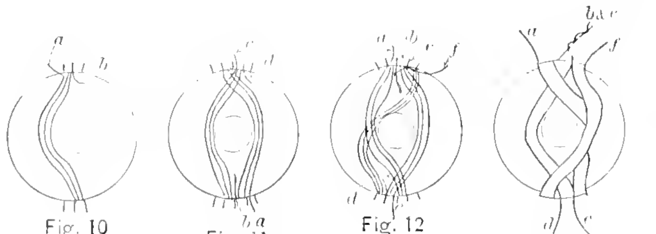


Fig. 10 Fig. 11 Fig. 12 Fig. 13

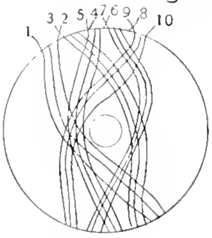


Fig. 14

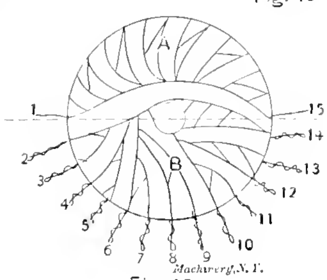


Fig. 15

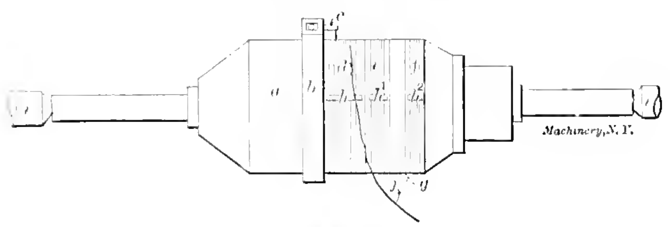


Fig. 21.

the workman's head, so that the wire will pay off freely. Cut the wire from the reel, leaving end b. The ends must be long enough to be soldered into the commutator.

Now turn the armature over and begin the second coil to the right of the first one. This will bring the second coil to the left of the first one at the bottom side, as shown in Fig. 11. The ends c and d are left for connecting to the commutator, as in the first instance. To commence the third coil, turn the armature over again and start at the right of the second coil, Fig. 12, twisting the end c around end b. Proceed in this

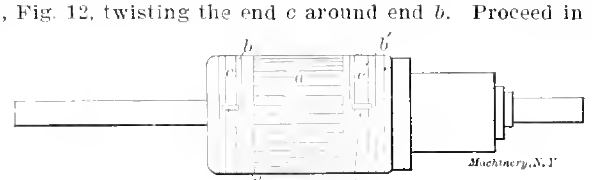


Fig. 22.

manner until all the coils are wound. Fig. 13 gives an idea of the appearance of the armature end after three coils have been wound. It will be seen that every second space between the pegs has two ends. The inner end of the first coil is connected to the outer end of the third coil, there being a blank coil between the two, thus forming a closed or re-entrant winding. Any number of layers or convolutions may be used in this winding. Fig. 14 shows a similar winding, that can be used for two layers or a multiple of two. The only difference is that the second coil is commenced at the ending of the third, and so on until every space is filled, as shown in Fig. 15. If the winding when completed is to be four layers deep, the coils from 1 to 15 inclusive will have two layers, and the remaining coils to be wound will also have the same number. The half, A, of the armature will have no ends at this stage of the winding. The second set of coils, whose ends protrude in the half, A, commences at 15 and extends around to 1. The outer end of one coil joins to the inside of the

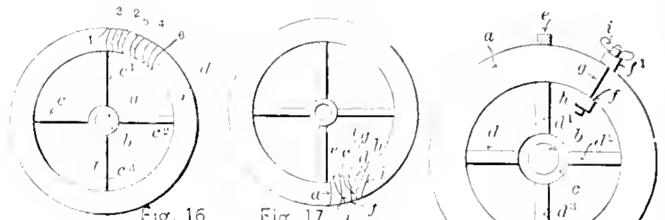


Fig. 16 Fig. 17 Fig. 18

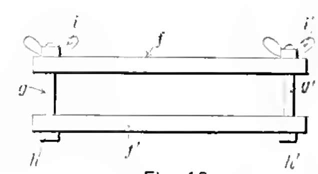


Fig. 19

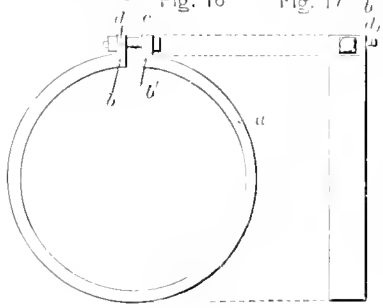


Fig. 20

next. This is clearly shown in Fig. 14, where end 3 of the second coil joins end 2 of the first coil, and so on. It is unnecessary to cut the wire, as it can be left in loops as shown at 1, 2, 3, etc., in Fig. 15.

We will now turn to smooth-core ring armatures. In Fig. 16, a is the shaft and b the spider hub, to which are attached the wings, c, c^1, c^2 and c^3, bearing the ring, d. The winding forms a continuous spiral, the end 2 of coil 1 being attached to end 3 of coil 2, etc. As the space on the inner surface of the armature is less than that of the periphery, the winding will have a greater number of layers inside than on the outer surface. An exaggerated view of a method of winding to accomplish such a result is shown in Fig. 17. The wire starts at a, then passes around the ring and comes to the front at b, passes under at c, and returns at d. It is then carried under at e, between a and c, starting the second layer on the

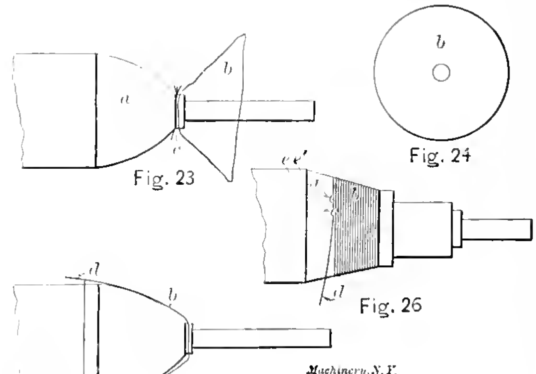


Fig. 23 Fig. 24 Fig. 25 Fig. 26

inner surface. From f, the wire goes to g, and back to h, thence to i, between c and g, coming back at j. Thus we have five convolutions and one layer on the outer surface, and two layers—one of three and one of two convolutions—on the inner surface.

In Fig. 18 the application of the clamp shown in Fig. 19 is given. This clamp consists of two wood pieces, f and f', and two bolts, g and g', with heads, h and h', and thumb nuts, i and i'. This clamp serves to hold the wire of each coil in position while winding, and is moved around as fast as a coil is completed. Referring again to Fig. 18, the wood piece, e, is used for filling the gap in the outer surface of the winding caused by the spider wings, d, d^1, d^2, d^3. It is made equal in width to the wing, and of the same depth as the winding. In bal-

ancing an armature one or more of these strips may be removed and lead strips wound in tape substituted.

All armatures must be carefully balanced, which can be accomplished by several methods, one of which has just been mentioned. If the air-gap of the machine has clearance enough, solder may be flowed onto the bands. With slotted armatures, some makers bore holes in the core on the heavier side, thus equalizing the weight. Another method is to bind a piece of sheet lead on the front end of the armature over the lead wires, by a tape and cord.

As no definite rule can be given for soldering lead wires into a commutator, only a few suggestions will be offered. Tin the slots in the segments and the armature leads before soldering. See that the slot is flowed full of solder. Do not use acid for flux on small wire, as corrosion will take place. Be extremely careful that no drops of solder lodge between or back of the segments. Each coil should be tested for grounds as it is wound, and to make sure that the right ends are connected. A convenient testing arrangement was explained in a previous article entitled "Commutators," and can be applied to this purpose. A magneto bell, a galvanometer or a Wheatstone bridge may be used for testing purposes.

Fig. 20 gives two views of a clamp that is used in winding armature bands, *a* being a hoop of band-iron, with its inside diameter equal to the outside diameter of the armature. The ends *b* and *b'* are bent up as shown, and bored to receive a clamping bolt, *c*. A pin, *d*, is attached to the end, *b*, for fastening the binding wire.

Fig. 21 shows clearly the practical application of the clamp. In this sketch, *a* is the armature; *b*, the clamp; *c*, the pin; *d*, the band being wound; *e* and *f*, finished bands; *g*, mica insulation under bands; *h*, h^1 and h^2, brass clips for holding the bands together. The lathe centers are shown at *i* and *i'*. The end of the brass wire *j* passes through the fiber friction blocks in the toolpost.

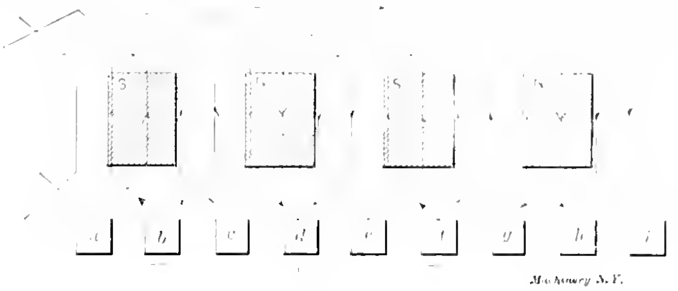


Fig. 27.

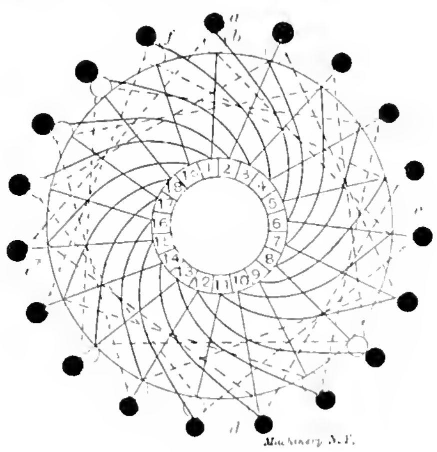


Fig. 28

The manner of winding an armature is essentially the same as that of a commutator, which has already been fully described in an article under the latter head.

A completed armature, with slots of the type shown in Fig. 6, is illustrated in Fig. 22. The core, with wood retaining strips driven into slots, is shown at *a*. Mica strips *b* and *b'*, under bands *c c*, are for the usual insulating purpose. Brass chips *d* and *d'* are attached in the regular manner. Armatures with wood retaining-strips in slots require but two bands, which are wound on the coil ends that project beyond the core.

A method of protecting the ends of a surface [illegible] armature is illustrated in Figs. 23, 24, 25 and 26. A [illegible] disk, *b*, Fig. 24, is tied by a cord, *c*, to the end of armature [illegible] Fig. 23. The disk is then drawn over the end and tied temporarily with a cord, *d*, as in Fig. 25. The armature band serves to hold this hood in place permanently.

An effective manner of finishing the commutator end of an armature is illustrated in Fig. 26. The end, *a*, is wound tightly with cord about 1/4 inch in diameter, as shown at *b*. Two loops of string, *c* and *c'*, are caught under the last two or three turns of cord and the end, *d*, is passed through them, after which the loops are drawn up, the ends trimmed off and the cord cut close to the last loop. After the armature is completed, it should be given a thorough coating of shellac and placed in an oven. When fully dried out, put on two even coats of P. & B. compound, which gives it a good black and waterproof finish.

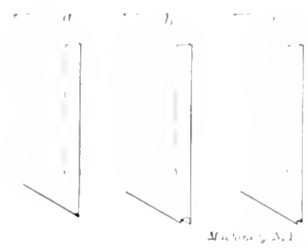


Fig. 29

As a complete description of the numerous styles of connecting up armatures is beyond the scope of this article, only a few of the common types will be taken up. For further information on this subject the reader is referred to one of the many text-books on dynamo-electric machinery.

Fig. 27 illustrates, graphically, a lap-winding. The poles of the machine are represented at *S*, *N*, *S*, *N*, and the commutator segments are indicated by the squares *a*, *b*, *c*, etc. We will take, for example, the coil starting at *b*. The conductor passes over the left face of the *S* pole, and then returns over the middle of the *N* pole, to the adjoining segment, *c*. This series of loops is continued around the armature, forming a complete circuit. The large arrow indicates the direction in which the conductors are moving, and the small arrow-heads on the wires show the disposition of the current.

A diagram of a hand-wound armature, with a wave winding, is shown in Fig. 28. To avoid complications, nineteen coils only are shown. This type of armature is extensively used by the Shaw Electric Crane Company. The small white circles around the circumference of the armature, as at *b*, represent the first layer of wire; the black circles, at *a*, show the outer layer. The dotted lines indicate the conductors passing over the back end of the armature. Starting at the commutator segment 1, the conductor goes to *b*, then to *c*, and connects to segment 10. Here we start a new coil, going to *d*, then to *e*, and connecting to segment 19, one remove from the starting point. The third coil starts here and leads to *f*, and so on until one layer is completed, when one-quarter of the circumference of the armature on each side will have ends protruding, that is, the first quarter will have leads, the second will be blank, the third will have leads again, and the fourth will be blank. Start the second layer at the end of the first one. When the winding is completed, each slot will have two ends, as shown in the figure. An armature with formed coils can be connected in a like manner.

A few handy tools can be made from fiber; they are shown at *a*, *b* and *c*, in Fig. 29. These tools are used for driving the wires into place, etc.

Rewinding an armature requires great care and neatness. The dimensions and shape of the original winding should always be closely followed, as an armature which is but a fraction of an inch too large is useless.

* * *

Referring to the item "Cast Iron Sinks" in the November issue, Mr. Robert Grimshaw, Hanover, Germany, writes: "'Cast Iron Sinks' is at any rate true, but how about the sign in the next window of the same plumber's shop, 'Copper Floats?' If we believed that literally, we would believe anything."

TOOL MAKING.—13.

MILLING MACHINE CUTTERS.

E. R. MARKHAM.

Milling machine cutters are either made solid or with inserted teeth. Those 6 inches and under in diameter are usually made solid, but in most shops those over 6 inches are made with inserted teeth, though in some it is considered good practice to make them solid up to 8 inches diameter. Certain forms of cutters, much larger than the size mentioned, must be made solid, and it is advisable when hardening these to employ a method that will insure the desired degree of hardness with little or no risk of cracking.

When selecting steel for cutters first price should never be a consideration provided the higher-priced article is the best for the purpose; however, for most purposes, steel can be procured for a reasonable price that answers as well as some of the more costly ones. There are several alloy steels on the market, made especially for cutters of this class, which work nicely; they will stand higher speeds and run longer between grindings than steel made for all-around work. Most of these, however, are rather "cranky," and require very careful treatment in the fire and hardening bath, and should not be used unless the hardener is thoroughly experienced and understands handling "special" steels. If conditions are such that they can be worked successfully they prove very satisfactory and their use is to be advocated; on the other hand, if conditions are not favorable they give best satisfaction "when left alone."

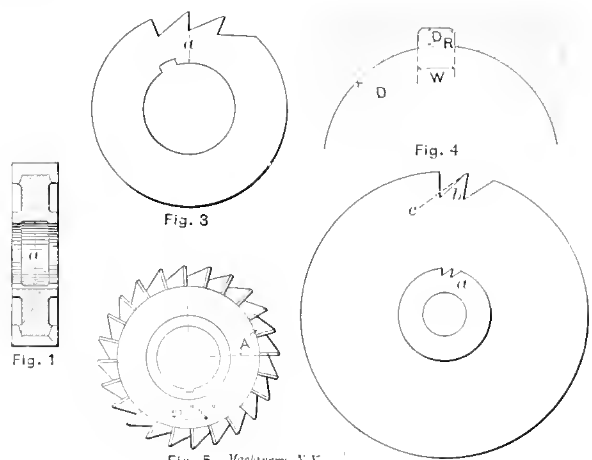


Fig. 1 Fig. 3 Fig. 4 Fig. 5 Fig. 6 *Machinery, N.Y.*

It often happens that a cutter is desired which calls for stock larger than any on hand, and as but little is wanted, and that little right away, it seems advisable to take a piece of the largest available and upset it to a size that will machine to the desired dimensions. Right here we meet a whole "heap" of trouble. When steel is made, the drawing by rolling and hammering is all in one direction—namely, in the direction of the length of the bar. Now if the steel is upset *somewhat*, the "grain" is in all directions, and the adhesion between the molecules is weakened perceptibly; and when the steel is hardened it is liable, and in fact almost sure, to go to pieces, or at least crack in all directions. But if the piece of steel is upset enough to overcome this difficulty the trouble mentioned will not be experienced. As an illustration, the writer at one time saw a cutter 6 inches in diameter, stock for which had been upset from 5-inch steel. The upsetting was done on an anvil, by means of hand sledges, and the cutter was finished to size and shape. When hardened it went to pieces, the cracks running from center to circumference in irregular lines. Another cutter was made at the writer's suggestion from a piece of 4-inch stock upset under a steam hammer. The hardening was done by the same man, in as nearly as possible the same manner as the first one. It came out all right, as have a number of others made since then. Of course this can be carried to an extreme, but unless stock is to be upset sufficiently to change the direction of the "grain" steel that is to be hardened should never be upset at all.

As has been stated a number of times in these articles, there is a decarbonized portion at the surface of all tool steel as it comes from the steel mill. Stock must be selected sufficiently large to allow removing this surface when the cutter is machined to size. When upsetting steel it is best to allow more than would be necessary when cutting from a bar of the right size; for the steel at the circumference, not having anything to restrain it, flows under the blows of the hammer more readily than any other portion, and as this is the very portion where strength is required, sufficient stock should be removed to cut away this portion. Of course we could hammer around the circumference with light blows, but the effect would not be that desired, as we might again change the grain. The writer's experience has convinced him that while it does very well to occasionally hammer around the circumference when flattening out, there should be no heavy blows—if any at all—after the final blows of upsetting.

When forging large pieces of steel it is necessary to strike blows sufficiently heavy to make the steel flow as uniformly as possible. Light blows on the surface of a large piece of steel have the effect of drawing a portion of the surface away from the stock underneath, and this will break away when the contraction incident to hardening takes place, or if not then, it is sure to do so when in use. On the other hand, extremely heavy blows on small sections crush the grain, thus spoiling the steel.

Steel for cutters should be annealed after a hole has been machined in the center, and the blank blocked out somewhere near to shape. The object in annealing is not necessarily to make the steel soft, but to remove the strains set up in the steel by the operations of rolling and hammering in the steel mill, or forging in the blacksmith shop. If a piece of steel is annealed ever so thoroughly when solid and a hole then machined in it, strains are liable to manifest themselves in a very unpleasant manner when the piece is hardened. If, however, the piece when annealed is, as near as is practicable, of the same form as when hardened, all harmful tendencies will be overcome by the annealing process. The hole made must be somewhat smaller than finish size—say 1-16 inch—and the diameter of the cutter must be somewhat large. All scale on the surface must be removed and the steel annealed. There are several methods of annealing, probably the most satisfactory being the packing in a hardening box with powdered charcoal, placing in the furnace and running until the steel is uniformly heated to a low red. The annealing heat should be as high as the hardening heat, to overcome strains; but never high enough to open the grain. The steel should not remain *red* hot any longer than is necessary but it should be a long time in cooling off *from* a red heat. An excellent method which can be practiced in almost any shop consists in placing hot ashes in an iron box—or other receptacle—to the depth of 2 or 3 inches. On this place a piece of board and after the steel has been uniformly heated to a *low* red lay it on the board with another board over it and bury the whole with hot ashes. Pieces annealed by this method are not likely to be over-annealed, and as they cool below a red more quickly than with the former-mentioned method, and yet cool from a red to a temperature of 300 or 400 degrees F. very slowly, excellent results are nearly always obtained, provided the heat was uniform.

A common practice is to heat red hot and place in a box of cold ashes, or lime. Ashes and lime should be well heated before the steel is placed in them, which is done by heating a piece of iron, or scrap steel, red hot, placing in the ashes or lime and allowing it to remain while the steel to be annealed is being heated. It is then removed and the steel put in its place. It must always be borne in mind that if the red-hot metal is brought in contact with cold or damp substances, the heat is extracted from it rapidly, thus causing it to harden somewhat. Moisture, even though it be warm, must be avoided in anything that red-hot steel is buried in. For steam, if projected against red-hot steel, under certain conditions, would cause it to harden. For this reason never bury steel in damp ashes or lime.

After annealing, place the blank in the lathe chuck and machine the hole to desired size. In many shops it is the custom to make the hole about .005 inch smaller than the milling machine arbor on which it is to be used, and after

hardening it is ground to size with the internal grinding attachment provided with all universal grinding machines. In shops where there is no appliance for internal grinding, the blanks are very carefully annealed to remove, as far as possible, all strains incident to working in the steel mill or forge shop, then the hole is machined .0015 or .002 inch smaller than the arbor and is lapped to size after hardening. When I say arbor I do not wish to be understood as advocating working to the milling machine arbor, as all holes should be ground to a standard gage, a hardened plug gage or a standard disk. When the hole is machined to the required size the blank is placed on a mandrel and machined to the desired length and diameter.

To facilitate grinding or lapping the hole to size after hardening it is advisable when machining it to recess it, as shown in Fig. 1, leaving a bearing portion at each end. For, the same reason it is generally considered best to cut away a portion at each end, as shown at *a*, Fig. 2, thus saving time

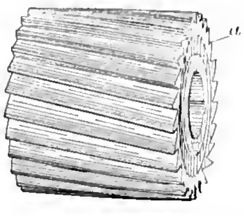


Fig. 2.

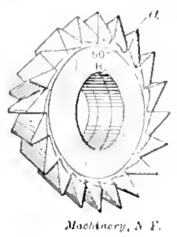


Fig. 7.

when grinding the ends. The operator should never leave ***sharp*** corners when recessing the holes, or cutting in at the ends, as sharp corners are likely to cause cracks when the steel is hardened.

The number of teeth in a milling machine cutter is a subject that has been debated for years, and one on which mechanics fail to agree, as conditions vary in different shops. Most manufacturers, I think, are agreed that reasonably coarse teeth work better than fine, for with the latter it is necessary to feed very slowly, as the spaces between the teeth fill with chips, thus causing the teeth to break. The following, from Brown & Sharpe's book, "Construction and Use of Milling Machines," seems to express the opinion of most men whom the writer has met who have had a broad experience in milling machine work: "Of late years mills have been made with coarser teeth than formerly, the advantages being more room for the chips and less friction between the teeth and the work. When the teeth are so fine that the mill drags, or where the stock is powdered, the mill heats quickly and does not cut freely."

When cutters are used on hand milling machines it is generally necessary to make the teeth somewhat firmer than when they are used on power milling machines.

It is considered best practice in most shops to make cutters of as small diameter as possible consistent with economy. By this is meant they should be large enough to allow of working over two or three times if this is practicable. Speaking from a theoretical standpoint each tooth should do its proportionate amount of cutting and the feed can be graduated to correspond with the number of cutting edges. But experience has proven that it is almost impossible to get a cutter on a milling machine arbor and have it run true enough to insure all the teeth cutting. And when but comparatively few teeth are doing any work it is necessary to feed as fine as when using a smaller cutter, and the speed of the cutter is necessarily slower, so the progress made is not as great.

In designing cutters, however, they must be of a size that insures sufficient strength at the point between the hole and the bottom of the cut between the teeth. The distance necessary to insure the proper amount of strength depends somewhat on the nature of the work to be done with the cutter. However, for general use there should be at least ⅜ inch at this point, as shown at *a*, Fig. 3. If milling cutters are hardened by the process known as "pack hardening" this space may be made somewhat less, as the steel will not be as brittle as if hardened by the ordinary methods.

To prevent the cutter turning on the milling machine arbor a keyway must be provided. In order that cutters having holes of given diameter may have a given size of key, manufacturers of milling machine cutters have adopted standard sizes of keyways. Fig. 4 represents a sectional view of a portion of a cutter showing a keyway, and herewith is given a table of sizes. The various dimensions are designated by letters, as will be readily seen. The drawing and table are taken from Brown & Sharpe's catalogue and apply to cutters furnished by them:

Diameter (D) of Hole.	Width (W) of Keyway.	Depth (D) of Keyway.	Radius R
3-8" to 9-16"	3-32"	3-64"	.020"
5-8 to 7-8	1-8	1-16	.030
15-16 to 1 1-8	5-32	5-64	.035
1 3-16 to 1 3-8	3-16	3-32	.040
1 7-16 to 1 3-4	1-4	1-8	.050
1 13-16 to 2	5-16	5-32	.060
2 1-16 to 2 1-2	3-8	3-16	.060
2 9-16 to 3	7-16	3-16	.060

Cutters used for cutting narrow surfaces have their teeth cut straight. In some shops all cutters used in cutting surfaces wider than ½ inch have their teeth cut spirally; in others they are cut straight unless ¾ inch or more in width.

The shape of the tooth plays a very important part in the way the cutter works. If the tooth is slender it springs into the work when heavy cuts are taken, as explained in the article in the December issue. It has been found by experiment that a cutter tooth having its face and back at an angle of about 50 degrees, as shown at *A*, Fig. 5, insures a strong tooth and sufficient depth of groove between teeth for chips. To produce a tooth of the proper shape for cutters of various sizes it is obvious that angular milling cutters of various angles are necessary. A cutter that would produce a tooth of the desired shape on a mill 2 inches in diameter would not

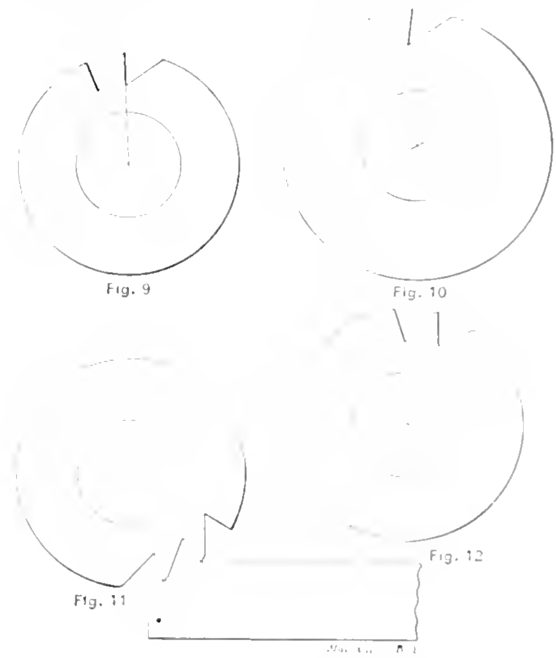


Fig. 9

Fig. 10

Fig. 11

Fig. 12

answer when producing teeth on one 6 inches in diameter. This is shown in Fig. 6, where *a* represents a portion of a cutter of 2 inches diameter whose teeth are produced with a cutter of 60 degrees angle, and *b* a tooth produced by the same cutter on one 6 inches in diameter. The dotted line shows the back of tooth if it and the face were at angle of 50 degrees. The tooth should be left about 1-32 inch broad across the top. The exact measurement cannot be stated arbitrarily; for small mills and light cuts .02 inch answers nicely, while for large mills which are to take heavy cuts it is necessary to leave them .04 inch across.

The angular cutter for producing the teeth should have the corners of the teeth, *a*, Fig. 7, slightly rounded rather than sharp. The amount of round need be but slight, but it makes a stronger cutter when the groovers are cut a trifle rounding in the bottom and it also reduces the tendency to crack when the cutter is hardened, sharp corners being an invitation to crack.

Milling Cutters with Spiral Teeth.

It is necessary when cutting mills of this type to use an angular milling cutter—having a slight angle on one side and the other side of a shape that will form an included angle of the form of the groove to be cut. The side which cuts the face of the tooth is generally made of an angle of 12 degrees, as shown in Fig. 8; while the opposite side may be either 40, 48 or 53 degrees, according to the size of the cutters to be cut.

When rigging up the universal milling machine if the angular milling cutter is set as shown in Fig. 8, so the distance *A* is about 1-12 the diameter, the face of the tooth cut by the side having an angle of 12 degrees will be nearly right for cutters of the usual proportions. The setting of the angular mill for the location of tooth must be made before turning the spiral bed to the desired angle of spiral. For cutting spiral milling cutters choose a helix that will produce the desired angle on the cutting edge. This varies, but for general purposes an angle of about 15 to 20 degrees with a plane passing through the axis of the cutter, gives good results. The helix may be either right- or left-hand, as desired, but unless the arbor is supported at the outer end it is best to make it of a hand that will force the arbor into the hole in the spindle rather than tend to draw it out. Then again it is better to have the thrust caused by cutting action against the solid shoulder of the spindle at the outer end of bearing rather than against the take-up nuts on the inside end of bearing.

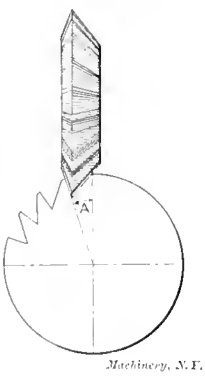


Fig. 8.

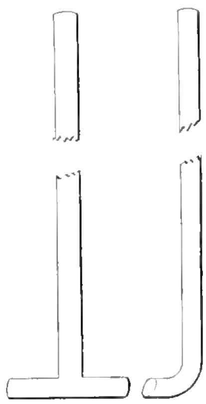


Fig. 13.

If two cutters are to be used on the same arbor it is a good plan to cut one with a right-hand spiral and the other with a left. In this manner the strain is equalized. This might, however, be objected to by some, on the ground that it would be more difficult to grind two cutters whose teeth were of opposite spirals to exact size than if they were of the same hand; but this need be no objection if reasonable care is exercised when grinding.

When the mill is to be used for the general run of work the cutting face of teeth is usually made radial and it is safe to say that as a rule the face of the teeth should be radial, as shown in Fig. 9. For certain classes of work it is necessary to depart from this custom. When the cutter is to be used for sinking a slot into a piece of metal it works better if the teeth are cut somewhat hooking, as shown in Fig. 10. When a mill is to be run onto the work, as shown in Fig. 11, there is less liability of its being drawn onto the stock and catching if the teeth are given a negative rake, i. e., cut ahead of the center, as shown in Fig. 12. While the generality of shops make cutter teeth radial, there are large manufacturing concerns which make most of their cutters with their faces receding, as shown in Fig. 10. However, to prevent chattering it is necessary to use heavy, stiff milling machines and to provide arbors somewhat larger than when cutters with radial teeth are used. Teeth cut as shown in Fig. 10 cut more readily than those cut radial.

As previously stated, no arbitrary rule can be given for the number of teeth for a cutter of a given size. Yet it is necessary to have a standard—if it can be so called—which may be departed from as occasion requires and the following table was in use in a shop where the writer was in charge and seemed very satisfactory:

Diameter of Cutter.	No. of Cutting Edges.	Diameter of Cutter.	No. of Cutting Edges.
½"	6	2½"	20
¾	8	3	24
1	10 or 12	3½	26
1¼	14	4	28
1½	16	5	30
2	18	6	32

If reference is made to engineers' hand books for information it will be found that various authorities are cited and that in some cases the pitch advocated by these writers differs greatly, showing that the distance apart of the teeth to insure best results depends on the class of work and the machine employed when doing it, as well as on the ideas of the designer in charge.

If the angular cutter used when cutting the teeth was in proper condition it should leave the surfaces of the teeth very smooth. The size and distinguishing marks should be stamped on the cutter, and then it is ready for hardening. If possible use the method known as pack hardening, as all danger of cracking is eliminated, and the cutter can be run much faster than when hardened by the ordinary methods; and even at the higher speed it will stand up longer between grindings.

If the cutter is to be pack-hardened and is made of steel containing more than 1¼ per cent carbon, use charred hoofs rather than charred leather as packing material. Do not use any wood charcoal, but simply charred hoofs. This method was described in a previous article. If necessary to harden by the ordinary methods, best results when heating are obtained by the use of some form of muffle furnace. Of these there are several forms on the market, any of which give good results. If only an open fire is available excellent results may be obtained if the operator will use the proper amount of care when heating. Have a large, high fire so as to get the cutter well up from the blast inlet. Use a *new* fire of charcoal, but have the coal well lighted so the heat will be uniform around the cutter. If an old fire (one that is nearly burned out) is used considerable blast will be needed to keep it alive and the air from the blast striking the heated cutter will cause innumerable cracks in the lighter portions of the teeth.

The cutter should be heated as rapidly as possible and the heat should be uniform. Do not attempt to force the fire, or the teeth, being lighter than the balance of the cutter, will heat more rapidly and so become overheated before the center is hot enough. The heat must be uniform and no higher than necessary to produce the desired result. A piece having projecting portions, like the teeth of a cutter, need not be heated as hot as a solid piece of the same size.

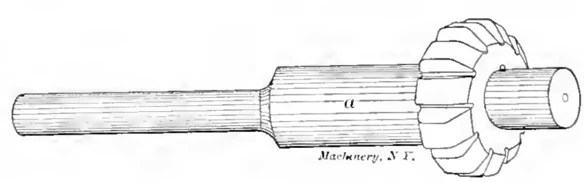


Fig. 14.

Should the cutter, through carelessness, become overheated, do not, as is the custom with some hardeners, hold it exposed to the air until it has apparently cooled to the desired temperature, and then plunge in the hardening bath; the grain of the steel always shows the effect of the highest heat it receives until it cools, and is again heated. Then again the surface cooling more rapidly than the internal portions would apparently be about right, while the stock nearer the middle would be much hotter; in other words it would be unevenly heated, and would contract unevenly and be very apt to crack. An overheated piece that is not *burned*, may be laid to one side and allowed to cool off, then reheated and hardened. If allowed to cool to a low red from a high heat and dipped, and it did not crack, the grain would be open and the steel weak, and it would crumble when in use.

Care must be exercised when dipping milling machine cutters in the hardening bath that the heat will be taken from the cutter by the bath uniformly. For this reason I prefer a bath having perforated pipes coming up from the

sides, by means of which jets of liquid are projected against the teeth uniformly at all points. If such a bath is not at hand, the cutter must be worked around in the liquid quite rapidly, to insure uniformity of results. Cold baths should not be used for this class of work, as they cause much trouble; the writer prefers a bath of brine which is of a temperature of about 70 degrees F.

As previously stated, all cutter blanks should be annealed after having a hole drilled through them and the outer surface of the stock removed, otherwise trouble may be experienced when hardening, especially if the cutter is to be of an irregular shape. Unless the cutter blank is annealed while in a form somewhere near that of the finished cutter, the strains in the steel will manifest themselves by irregular contraction when the cutter is cooling in the bath. To overcome this tendency to crack from unequal contraction, the cutter is slowly heated to a low red, removed from the fire and allowed to cool off until all traces of red have disappeared, when it may be placed in the fire again and reheated to the proper hardening heat and dipped in the bath. As the teeth are the only portion of the cutter which need be hard, the cutter may be removed from the bath as soon as it is hard and immediately placed in a tank of oil and allowed to remain until cool. Allow the contents of the bath access to all parts of the cutter. Hold the cutter in a manner that permits the liquid to circulate through the hole freely. A wire bent in the form shown in Fig. 13 answers nicely. The usual forms of tongs would not answer, as a portion of the outer surface would be covered by one of the jaws, thus causing unequal contraction.

After hardening, the cutter is reheated sufficiently to overcome any tendency to crack from internal strains due to hardening. It is then brightened, and the temper drawn to a light straw color, by placing on a plug of the form shown in Fig. 14. Do not have the portion marked *a* fill the hole in the cutter. Before placing the cutter on this plug it is heated somewhat, as the extreme heat in the plug if brought in contact with the walls of the hole in the cold cutter would cause rapid expansion, and perhaps cracking. While on the plug the cutter is held over the fire and the outer portion heated thereby, and when the proper temper color is visible, it is placed in warm oil and allowed to cool to the temperature of the oil. When a number of cutters are to be tempered, best results are obtained by heating in a kettle of oil, gaging the heat by a thermometer, 430 degrees being equivalent to a light straw color. If the cutter is hardened at the proper heat—the refining heat—the temper need not be drawn as low as when higher heats are employed.

Before grinding the hole in the cutter to size, remove all scale and gum, as this tends to glaze the wheel. The hole should be ground to a standard. The outer end of the cutter may be ground before removing it from the chuck, which insures the end being true with the hole. Then remove the cutter from the chuck, and hold the cutter on an expanding plug, with the end that has been ground against the faceplate provided for such purposes, and grind the opposite end as shown in Fig. 15.

It is customary in some shops to simply grind the walls of the hole while the cutter is held in the chuck, the ends being ground while the cutter is held on a mandrel like that in Fig. 16. By this method the ends must be parallel. However, if reasonable care is exercised regarding the condition of the faceplate and freedom from dirt, excellent results are obtained by the first-named method.

After grinding to length, the teeth are given the necessary clearance for cutting. A suitable wheel should be used, free from glaze to avoid any possibility of softening the cutter teeth by the heat generated by friction between a glazed wheel and the cutting tooth. A machine shop having even a few milling machines should be provided with suitable means of grinding the cutters. A dull mill wears away very rapidly and produces very unsatisfactory work and it pays to exercise care as to the condition of the teeth.

The wheel used on the cutter grinder should be as large as can be conveniently used without danger of striking the adjoining tooth. It should be the proper grade and number of emery (if an emery wheel). It is a mistake to use a hard wheel; it should be soft enough to allow of being easily scratched with a pointed instrument. The size of emery used in making the wheel cannot be definitely stated as the class of work must, in a measure, determine this, and wheels made of a certain size emery (or other abrasive material) by one manufacturer do not agree as regards results with wheels of the same size emery, and of the same designated grade, made by another. However, it is not generally best to use an emery coarser than 60 or finer than 90. A wheel of the proper grade should be about ¼-inch wide. If the wheels at hand are thicker than this, cut a corner off as in Fig. 17, until the face does not exceed ¼-inch width. If necessary to use a wheel that is too hard, the face should be narrower than the measurement given above; if very hard, reduce to ⅛ inch or even less. A soft wheel should be run faster than a hard one, but as a rule the maximum speed should not exceed 5,000 feet per minute; that is, the circumference of the wheel should travel at the rate of 5,000 feet per minute. This is termed the periphery speed. If the wheel is glazed, remove this by the use of a piece of emery wheel a trifle harder than the one being used. This produces an open appearance on the surface of the wheel.

For most purposes an angle of clearance of 3 degrees answers nicely; that is, 87 degrees from a radial line as shown in Fig. 18. When grinding for clearance, take light cuts and move the cutter tooth rapidly by the wheel. As so much depends on the emery wheel used for grinding for clearance, it is well to procure wheels of a reputable maker, stating when ordering, the class of work to be done. Their experience in

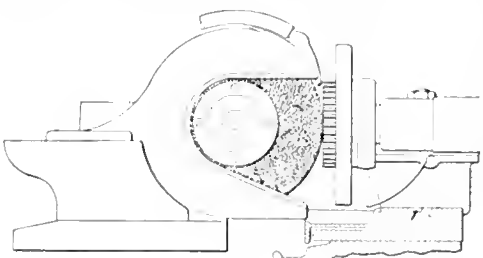


Fig. 15

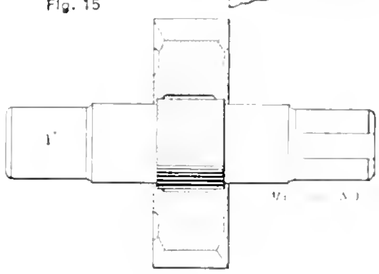


Fig. 16

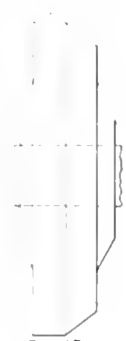


Fig. 17


Fig. 18

furnishing wheels for various purposes has taught them exactly what wheel is suitable for the job in hand.

When using mills suitable speeds and feeds must be employed. A 6-inch mill if run at the number of revolutions per minute that would be maximum for a 3-inch, could not stand up on the same work; the periphery speed must be right. When taking light cuts, a mill may be run more rapidly than when taking heavier cuts. When cutting hard metals a slower speed must be used than when machining softer ones. Cutters which are properly "pack hardened" will stand, as a rule, a speed 50 per cent greater than if hardened by ordinary methods. We must, however, have a basis from which to start, and some authorities claim for ordinary grades of machinery steel a speed of 35 feet, for cast iron, 60 feet; and for brass 125 feet, but as all these metals vary in hardness the above figures are only approximate. Cutters stand best when given proper feeds. If the feed is too coarse, the cutting edges are knocked off; if too fine, the cutter dulls owing to the teeth rubbing against the stock. In the ordinary shop there is greater danger of feeds being too fine than too coarse.

In the next article we will conclude the subject of milling machine cutters and take up side milling cutters, milling cutters with inserted teeth, etc.

* * *

If the job of being a foreman were not more difficult than being a mere machine man, it would not pay better.—*Woodworker.*

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets

IMPORTANCE OF ELEMENTARY PRINCIPLES.

In reviewing the steam turbine patents of the past century for the series upon this subject in the Engineering Edition, it has become evident to the writer that a great many inventors who have wasted their good money on worthless patents would have been far better off if they had invested the same amount in a course of lessons in the principles of physics, heat and steam. A fact that has been demonstrated time and time again is that the reaction of a jet of fluid, such as steam or water, when flowing from a nozzle, is equal and opposite to the impulse due to the momentum of the jet; and it makes no difference whether the jet discharges freely into the atmosphere or whether some obstacle is held in its path. So long as an obstacle is not placed near enough the outlet of the nozzle to choke the discharge, the reaction will remain the same, whether the jet strikes against some stationary object or not.

In spite of this well-known principle, many inventors have taken out patents on devices for turbines of the reaction type in which the jet is made to impinge against stationary projections as the wheel revolves, with a view to giving the wheel a harder push backward than the inventor believed would be the case if the jet flowed freely into the air. The idea appears to be prevalent that if the jet has an opportunity to push against something its effect will be greater.

One of the necessary requisites in a steam turbine is that in some way the speed of rotation shall be reduced, and what has seemed to many inventors to be a plausible method has been that of employing the injector principle for combining the steam with some heavier gas or liquid, with a view to reducing the velocity of the jet and hence the velocity of the wheel.

A turbine on this plan would undoubtedly work, but it would also cost many times more to operate it than its owner would care to pay for. The velocity of the combined jet consisting of steam and the other fluid—water, for example—is given approximately by the formula $V_1 = \frac{V}{W+1}$, where V is the velocity of the steam as it leaves the steam nozzle, and W is the weight of water used for each pound of steam. This formula is derived by the well-known principle that momentum before impact must be equal to momentum after impact. The ability of the steam jet to perform work on the wheel, however, is given by the expression $\frac{V^2}{2G}$ for each pound of steam, and of the water jet $\frac{(W+1)\,V_1^2}{2\,G}$. We will not attempt to apply these equations here, but the reader can easily perceive that inasmuch as the ability of the jet to do work is measured by the second power of the velocity and only the first power of the weight, the combining of the heavier fluid with the lighter will have the effect of reducing the kinetic energy and so of making the turbine inefficient.

What becomes of the kinetic energy lost in this process? Obviously part of it is converted into pressure and part of it appears as heat energy. The injector affords a striking example of this, where we find that, considered simply as a mechanical machine, without regard to heating the feed water, it will consume some 12 to 15 times as much steam per H. P. hour as a steam engine of the same power would consume.

* * *

THE POSSIBILITIES OF BOG FUEL.

Investigations of bog fuel made by the Insurance Engineering Experiment Station under the direction of Mr. Edward Atkinson apparently demonstrate beyond question that the possible exhaustion of our coal supply need not immediately trouble us, since this country possesses vast quantities of available fuel in its marshes and bogs. The Irish peasants have for generations been making use of peat, which practically forms their sole basis of fuel supply, but the bogs of Ireland differ from those in this country inasmuch as they are composed of moss and other vegetable products only partially decayed, while the larger deposits here are more of the nature of mud. Many failures have resulted from attempting to work the contents of mud bogs into fuel at low cost, and apparently for very simple reasons. The efforts heretofore have been to dry and then compress the fuel, using some other substance as a binding material to overcome its friable nature. This, of course, made necessary a lot of expensive machinery for compressing the briquettes, and required the addition of various foreign materials for the binder. According to Mr. Atkinson's report investigation in Germany disclosed the fact that the carbonaceous contents of these bogs consist of fixed carbon and hydrocarbon, the latter being a very adhesive substance contained in minute vesicles. These vesicles are broken up, which is done very simply by running the mud through a machine resembling a sausage chopper, and the broken hydrocarbon vesicles and their contents become diffused through the mud and act as a binder. Moreover, the mechanical breaking up of the mud mass liberates the water and allows it to evaporate rapidly under ordinary conditions. It is said that briquettes made in this manner contract or condense into a more or less solid form, in some cases increasing in specific gravity to that of the ordinary types of bituminous coal.

Apparently, from Messrs. Atkinson and Norton's reports, there are many opportunities for the development of fuel plants with comparatively small capital, wherever bogs or marshes of the proper constituency exist. Of course, many bogs are not possible sources of profitable fuel supply, and in any case careful investigation should be made before an attempt is made at development. Mr. Atkinson thinks that a plant costing about $2,500 will, as an average, turn out 20 tons of bog fuel per day, or allowing for holidays and storms about 5,000 tons per year. There are many regions now, more or less remote from coal mines, where a cheaper fuel supply would be greatly appreciated, and if such happen to possess supposedly worthless swamps, it may be instead that they have an inexhaustible supply of good fuel at their very doors.

* * *

While high-speed steel is said to make excellent razors, it appears inadvisable to use it for this purpose, if we accept the testimony of one of the members of the Iron and Steel Institute at the recent New York meeting. He said that there had been one curious fact noted in connection with high-speed steel. Any wounds caused by it are very painful and take a long time to heal.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

From a cursory examination of some of the mechanical toys exhibited for sale in the shops and stores in great numbers at Christmas time, it would seem that the makers thereof have arrived at the acme of accomplishment in the manufacture of machines that will actually run—for a very brief period—and then, like the deacon's "one-horse shay," they go to pieces all in a day.

An amusing example of the perplexities that frequently beset the piecework shop was furnished at the last meeting of the National Railroad Master Blacksmith's Association. In the discussion on high-speed steel one of those who took part related how one of their machine men had suddenly greatly increased his output over that of the other men. For some time it was a mystery how he was able to turn out work so fast, and then it was discovered that he was more progressive than the firm and had secretly bought some high-speed steel for his own use, and was thus reaping the benefit of his progressiveness in the shape of good hard cash. Now let the managers of piecework shops arise and tell us how they would have handled a case of this kind prior to finding out what was the reason of this man's extraordinary production, and what they would have done afterward.

A circus train was pulling out of Spokane, Wash., a few weeks ago when suddenly the injector "broke" and persistently refused to take up water. After working with it a few minutes the engineer ordered an examination made of the tank; it was found nearly empty, although filled at the water crane but a short time before. No explanation of this mystifying condition was apparent until water in numerous streams was seen running from the elephant car next to the tender, and then the cause was found. "Jumbo" had amused himself by reaching his trunk through the open end of his car into the manhole of the tender and sucking up the water with which he had deluged the other animals in the car. They looked like "drowned rats," and needless to say had enjoyed their involuntary baths no more than the trainmen had the delay.

Not long ago it was freely predicted that much of the large machinery provided in our leading electrical and steam engineering works would become more or less useless on account of the much smaller sizes of units made possible by the steam turbine, but apparently the growth of the big machine tool industry will suffer little or no check from the advent of the steam turbine. The huge turbines now building for the 25-knot Cunarders have made necessary the building of a number of large special machines, one being a boring machine for the casings, constructed by Thomas Shanks & Co. for John Brown & Co., Clydebank. The total weight of this machine is about 95 tons and it has an over-all length of 76 feet. The base plate is 17 feet wide and 53 feet long, with wings bolted to each side where necessary to serve as supports for the overhanging parts of the turbine casings.

One of the interesting exhibits at the Louisiana Purchase Exposition was a steel boiler plate made by Worth Brothers, Coatesville, Pa., which is said to be the largest boiler plate ever rolled. It is 558 inches long, 142 inches wide, and 0.72 inch thick. The total weight is 16,120 pounds. The tensile strength of the material is 58,000 pounds per square inch; the elastic limit 37,000 pounds; and elongation 37 per cent. There is a most striking difference between this monster plate and the small iron plates available, say, one hundred years ago. It will be remembered in the article "Early Steam Engines.—3," which appeared in the August, 1901, issue of MACHINERY, it was stated that the firebox of the boiler of the Center Square pumping engines at Philadelphia, Pa., was made of wrought-iron plates 15 x 36 inches. These were the largest that could be obtained at that time.

In a paper on the modern steam fire engine read by Mr. F. F. Loomis before the ninth meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, it was stated that the first steam fire engine dates back to 1840 and was built by Mr. P. R. Hodge, a mechanical engineer of New York City. Strange to say this machine was of the automobile type, being self-propelling. The rear wheels, which were the drivers also, served as balance wheels when the engine was in use at a fire, the machine then being jacked up so as to clear the ground. Although it worked very well for its small capacity, weighing only 3,000 pounds, it was opposed by general prejudice and by the volunteer fire departments of those days, and allowed to fall into disuse. Mr. A. B. Latta built the next steam fire engine for the city of Cincinnati in 1852, and its great success paved the way for its general adoption in all cities.

The ice man is an important personage during the hot term, but there are indications that his vocation may be less important to many in future years. The ideal condition for every household maintaining a refrigerator would be that in which a refrigerating system is operated by power, preferably electric. Then the refrigeration could be maintained as the weather demanded, and not as suited the convenience of the ice man. We understand that a small electric refrigerating plant for the household has been placed on the market which has a capacity equal to the melting or use of about 200 pounds of ice per day. It is said to be automatic, and so simple in the matter of care as to be operated by the ordinary kitchen help. It is driven with a one-half horse power electric motor, which operated about half of the twenty-four hours will manufacture nearly 20 pounds of ice, besides refrigerating two storage compartments to a temperature of 35 to 38 degrees F.

Professor Bach recently made some experiments to determine the effect of high temperature on the strength of steel. The tests were made on groups of four bars each. The first four were tested at ordinary temperature, and the other lots at 390, 570, 750, 930 and 1,020 degrees F. respectively. At ordinary temperature the tensile strength of one bar was 51,000 pounds per square inch and the elongation 26.3 per cent. The tests on the successive lots showed that the strength increased with the temperature up to 750 degrees F., at which the total increase was about 6 300 pounds per square inch, but above this temperature the strength decreased directly with the temperature, and was found to be only 26,000 pounds per square inch at 1,020 degrees F. As a result of these tests the professor thinks that boiler steel plate should also be tested at higher temperatures than normal, as there are surprising variations from the results of tests made at ordinary temperatures.

In the paper "The Development and Use of High Speed Steel," read by Mr. J. M. Gledhill before the Iron and Steel Institute, it was intimated that the famous Damascus steel of antiquity, to which marvelous cutting powers have been attributed, is really a form of high-speed steel, containing as it does those alloys which have been found necessary in the manufacture of our modern product. He states that Damascus steel contains certain percentages of tungsten, nickel, manganese, etc., and hence a latent high speed steel may be said to have existed centuries ago. All that was necessary to bring out its inherent powers was a very high temperature, such as was long thought to destroy its nature, in other words, "burn" it. It remained for Messrs. Taylor & White, of the Bethlehem Steel Co., to burn alloy steels and thus develop their high-speed quality which perhaps has worked and is working the greatest revolution in machine shop practice.

According to the statement made by the United States consul at Milan, Italy, that government has recently made an

interesting experiment with automobiles to demonstrate their emergency value in war time. Fifty owners of automobiles were invited to take part in the maneuvers and thirty responded. Thirteen routes were selected from Brescia leading to various points on the eastern, western, and northern frontiers. The thirty machines participating all left the town in the early morning, each bearing a sealed order containing the route laid out for that machine. The distance had to be covered within twenty-four hours, and means had been provided for verifying the routes, times of departure, etc. All the cars returned to Brescia before midnight of the same day, and only one of them had an accident. The longest distance covered was 335 miles. The result of the test is said to be highly gratifying to the military authorities, as it proves the great value of the automobile in war time for transporting officials, papers, maps, light apparatus, food, etc.

One of the most famous patents in the matter of litigation is that of James Knibbs, who some forty years ago invented a relief valve for fire engines. The invention was very simple, but is a very valuable adjunct to the steam engine, being practically indispensable in fire fighting. It essentially consists of a relief valve and pipe attached to the box to which the pumps deliver the water, and from whence the streams are distributed to the various lines of hose. The pipe to which the relief valve communicates leads back to the suction of the pump. When the fire engine is supplying water for fighting a fire, the demand for water is likely to be the full capacity of the engine, but one or more lines of hose may be suddenly shut off at any time without warning to the engineer. Without the relief valve the pressure would likely rise so high as to burst one of the remaining lines of hose, but with the Knibbs device the excess pressure merely raises the valve and allows the water to flow back to the suction where it is pumped over and over again. Thus not only the hose is protected but water is saved and the flooding of the streets prevented. Knibbs neglected to patent his invention until it had been used over two years. He then secured a patent for it and its use became general on fire engines. In 1877 suit was begun against New York City for infringement of the patent, and as time passed on the claims mounted up to over $26,000,000. The United States Circuit Court recently decided in favor of the city, holding that Knibbs had abandoned his invention, inasmuch as he did not secure a patent within two years of its inception.

RAISING THE MAINE.

Since the sinking of the *Maine* in Havana harbor, February 15, 1898, there have been many rumors that the wrecked vessel was to be raised by private contractors who expected to be recompensed for the work by the actual value of the vessel and its equipment, and the curiosity of the public who would be willing to pay a good admission price to view the relic. None of these proposed schemes have resulted in any actual work being done, so far as we know, but it now appears from the *Engineering News* that plans have been made, and work will soon be started by a salvage company. The United States government has relinquished all claim to the battleship, and it is now the property of the Cuban government, which desires to remove the obstruction from the harbor, where it is a serious menace to navigation. The salvage company proposes to build an immense wooden circular coffer-dam 354 feet inside diameter, with inner and outer concentric timber walls spaced 8 feet apart. Each wall will be composed of 3-inch pine planks, and the inner and outer walls will be tied together by radial and diagonal planks, and ¾-inch tie rods. The depth of the water where the Maine sank is about 35 feet down to a mud stratum, and the mud is about 20 feet deep before a hard stratum is reached, hence the coffer-dam may have to be built fully 55 feet high, provided it is found necessary to sink it completely through the mud stratum. It is proposed to build the dam complete and sink it around the vessel by loading it with about 2,000 tons of ballast. Water will also be admitted within the inner and outer walls. When the dam has been sunk to the mud stratum pumping will begin, which will facilitate the sinking of the dam through the mud. When the water has been pumped out, the work of temporarily repairing the vessel so that it can be floated will be done. The company is alive to its opportunities and will charge photographers a high price for taking photographs of the work and of the wrecked vessel as it is uncovered. They also propose to make up souvenirs of brass, bronze, and copper, which will be sold as mementos, and will be accompanied by certificates of Cuban and American officials as to their genuineness. After the vessel has been floated, it will be placed on the Havana floating drydock and there completely repaired. When repaired it is proposed to exhibit it in the principal seaports of the United States and charge visitors an entrance fee for the privilege of going over the vessel. After all these various sources of revenue have been exhausted the company will have on its hands a complete battleship which they will sell to some government. The Maine cost the United States something like $5,000,000 to build and equip, and the machinery alone cost $735,000. The proposed work is of great interest from both an engineering and a historical standpoint, as the coffer-dam proposition is perhaps the most ambitious of the kind ever projected, and, if successful, it will restore to the world a vessel round which much sentiment centers.

FANS VS. POSITIVE-PRESSURE BLOWERS.

An interesting and valuable paper to foundrymen was presented at the March 7th meeting of the Pittsburg Foundrymen's Association. It described tests which were made by a committee appointed by the association for the purpose of determining the relative efficiency of fans and positive-pressure blowers. The tests were conducted at the works of McIntosh, Hemphill & Co., on a 54-inch cupola, under the supervision and direction of Mr. W. H. McFadden. The first test was made with a Sturtevant No. 10 fan, driven by a 50-horsepower, 220-volt, shunt-wound motor. For the fan test the motor was run at a speed of 839 revolutions per minute, and the power required throughout the test was determined from voltmeter and ammeter readings. 60,700 pounds of metal was charged into the cupola, one-half being scrap and one-half pig. The test began at 2:02 P. M., and at 3:30 the first iron was run into the ladle, its temperature being 2185 degrees. The test was concluded at 5:50 P. M. During this period the average pressure of the blast was 13.6 inches, the average power required 35.8 electric horse power, and 57,680 pounds of iron were melted. The average amount of iron melted per hour was 15,312 pounds; 17,200 pounds per hour were melted during the first part of the heat, 15,000 pounds during the middle period, and 12,200 pounds at the last. The second test was made two days later with a 33-cubic foot Connersville blower. The same conditions existed as with the previous test with the exception that the piping to the cupola contained one more elbow. The same motor was used to drive the blower, and the cupola was charged with the same proportion of iron and scrap, but 63,000 pounds were charged instead of 60,700 as before. This test began at 2 P. M. and continued until 4:50. The average wind pressure was 20⅝ inches, and the average electric horse power was 40.6. The first iron was run into the ladle at 3:30 and indicated a temperature of 2165 degrees. The total amount of iron melted was 59,677 pounds and the time required was 2 hours 49 minutes as against 3 hours 46 minutes with the fan. During the first of the heat the iron was melted at the rate of 20,500 pounds per hour, during the middle at the rate of 22,300 pounds, and during the last at the rate of 17,700 pounds. A complete log of the tests shows that the average electric horse power for the fan was 35.8 and for the blower 40.6, as has already been stated. The highest horse power required for the fan was 43.2 against 48.3 for the blower. The fan required 134.8 horse power hours for 60,700 pounds, while the blower required 114.49 horse power hours for 63,000 pounds. Hence the fan required 4.41 horse power hours per ton of iron charged, and the blower, 3.63 horse power hours per ton, making a difference of 0.78 horse power hours in favor of the pressure blower; the difference in time for melting the two heats was 57 min., also in favor of the blower. This would allow the user of the blower to postpone putting on the blast

about one hour longer for a 30-ton heat than could be done with a fan. It has been found that the blower causes a much greater wear on the lining of the cupola than does the fan. Additional tests of a non-official character were also made with a No. 8 Sturtevant fan. The conclusions of the author are as follows:

1. The test has proved that, under favorable conditions, a 40-horse-power motor is sufficient to supply power for a blower or fan furnishing blast for a 54-inch cupola.

2. The rate of melting is not proportional to the amount of air supplied to the cupola. Too much air will tend to cool the cupola around the tuyeres and thus reduce the melting area.

3. In a 54-inch cupola when all heavy scrap and pig was charged, the 33-cubic foot positive pressure blower melted more economically and faster than did the No. 10 fan blower.

4. A No. 8 fan melted much more economically and faster when the cupola was kept open by a small amount of light scrap than did the No. 10 fan when all heavy scrap was used.

5. The high pressure produced by the positive-pressure blower has a much more severe cutting effect on the lining than had the lower pressure produced by the fan blower.

6. The original cost and the cost of installation of the positive-pressuro blower would considerably exceed that of the fan blower.

7. The actual saving in horse power is not a large item. The saving due to the shorter time taken by the blower would depend upon the number of men employed and the price of work.

8. The difference in economy between the two types of blower depends largely upon the cupola practice. The above tests would indicate that where the tuyeres were kept clean and the cupola not packed too tight, there would not be any great difference in favor of either of the types of blowers. If the tuyeres are allowed to become partially closed, the positive type would prove the better.

EXPERIMENTS WITH HIGH-SPEED STEEL DRILLS.

Abstract of Paper presented by W. W. Bird and H. P. Fairfield before the December Meeting of the American Society of Mechanical Engineers.

The introduction of the high-speed twist drill into modern machine shop practice has brought with it many new problems and the tests recorded in this paper were designed to supply some definite data on the subject.

In order to measure the twist or moment and the thrust of the drill an apparatus was devised to go on the table of a milling machine, the drill being held in a chuck in the milling machine spindle. The apparatus is in effect a double dynamometer. It consists of a chuck with trunnions, mounted on roller bearings so that it is free to revolve about its axis; at the same time it is free to move in the direction of its axis, being mounted on a carriage which is on rolls resting on the frame of the machine. This frame was placed on the table of a milling machine so that the axis coincided with the center line of the drill, which was driven by the spindle of the milling machine. The thrust of the drill is transmitted through the trunnion of the chuck to a plunger which is fitted to a long cylinder filled with oil. At the end of this cylinder is a smaller one also carrying a plunger. This small plunger is attached to a ball-bearing piston in a regular indicator. The drum of the indicator moves proportionately to the feed so that the card taken is a record of the thrust during the drilling of a hole. The chuck is held from turning by a steel band which is attached by a yoke to a second indicator, and a card from this one shows the twisting moment at each stage of the operation. Both indicators were calibrated before and after the tests.

The correct moments were obtained by hanging known weights over the chuck and noting the rise and fall of the pencil point. The thrust cylinder was placed in an Emery testing machine and known loads applied, and a corresponding record taken on the cards. From these tests, curves were plotted so that readings from the cards could be readily reduced to pounds. It was decided to take up first the drilling of cast iron with high-speed steel. Blocks of soft gray iron were obtained and tested in the machine itself so as to get a number for each set of experiments as near the same degree of hardness as possible. A 5/8-inch Novo steel drill was taken as a good representative of the new steels.

The first experiments were on the effect of speed or number of revolutions per minute, all other conditions remaining the same. The revolutions were varied, from 110 to 600 but no material difference was shown by the cards in either thrust or twist. In other words, the power required to turn the drill varies directly with the number of revolutions, while the thrust does not increase with the speed, but depends upon the feed or the advance per revolution.

The next set of experiments was made to determine the relation between thrust and feed, the revolutions per minute remaining constant. From the first set of experiments it was shown that the limit of speed would depend upon the endurance of the drill, and with heavy feeds 420 revolutions was not far from this limit. Accordingly, the second set was run at this speed, which for a 5/8-inch drill is about 70 feet per minute for the cutting rate for the outer edges, and for .020-inch feed a rate of drilling of about 8 inches per minute. The range of feed was taken from .004 to .020 inch per revolution, the drill at the coarsest feed being somewhere near its limit. These feeds were all positive, a train of gears being substituted for the regular belt drive. The following table shows the results:

TABLE I

Feed—inches per revolution—								
.004	.006	.008	.010	.012	.014	.016	.018	.020
Thrust—total in pounds—								
240	280	330	360	410	460	525	620	725
Moment—total in inch-pounds—								
55	67	83	92	103	115	124	132	138

The figures in regard to moments indicate that less power is required to drill a given hole in a given time by increasing the feed per revolution rather than by increasing the revolutions. For example, to drill a hole in a 1-inch plate in 10 seconds could be done by running the drill 600 revolutions per minute and feeding .010 inch per revolution, but would require more power than by running at 300 revolutions with a feed of .020 inch. The question of proper angle of drill was next considered and a set of experiments made with a constant speed and feed, the half angle varying from 37 degrees to 70 degrees, 22 degrees less and 11 degrees more than the standard 59 degrees. The following table shows the results:

TABLE II.

Angle of drill, deg.	37	45	50	55	59	65	70
Thrust in pounds..	215	225	240	260	290	325	375

It was found that with the drill ground with a smaller angle than 59 degrees there was less thrust, but when the angle was as small as 37 degrees, however, the drill would not stand up on repeated work. At 45 degrees it seems to do the work as well as at 59 degrees and with much less thrust. This would suggest a change in the standard angle for the new steels. The moment for the various angles remained practically constant, so that the driving power does not change with the angles of the drill.

Another interesting point in drilling which can be shown with this machine is the effect of first removing the center of the hole by the use of a small drill. Ten holes were drilled in a bar of cast iron with small drills, ranging from No. 53 to 1/2 inch in diameter and then each one counterbored with a 5/8-inch drill at 420 revolutions per minute and a feed of .008 inch per revolution.

Table 3 gives the thrust in each case and shows that a hole 1-10 inch in diameter takes off about one-half the thrust for a 5/8-inch drill.

TABLE III

Size of first hole—										
.000	.0595	.0760	.0935	.120	.157	.189	.221	.250	.375	.50
Thrust for counterbore—										
340	190	180	170	155	145	130	120	90	70	30

CONDENSERS FOR STEAM TURBINES.

Abstract of Paper by George I. Rockwood, read before the December, 1904, Meeting of the American Society of Mechanical Engineers.

Mr. Rockwood has recently installed a 400-kilowatt Westinghouse-Parsons turbine at the Atlantic mills, Providence, R. I., and in this paper gives some of the results of his experience with the installation, especially with reference to the condenser outfit. The condenser used is a 16-inch Bulkley injector condenser, and the falling of the injection water through the throat of the condenser is what constitutes the air pump, and it is found to be the only air pump needed, since a vacuum of 28½ inches of mercury can be maintained, regardless of whether steam is passing through the turbine or not. The action of the condenser is such as to warrant the belief that a 14-inch condenser would answer every requirement for a 400-kilowatt turbine.

The injection water comes 500 feet from the river to the power house under a slight head and is elevated into a vertical tank 30 inches square by 15 feet deep. The level of the water in this tank is maintained 6 inches below the water inlet nozzle of the condenser, and the injection pipe takes the water from the tank at a point near the bottom. Apparently the depth of the tank acts efficiently as an air separator, in view of the excellent vacuum maintained, and no air in the form of bubbles can be detected passing over into the condenser with the water.

The cost of a condenser equipment of this type, fully installed, with centrifugal circulating water pump, tank, piping and valves, ranges from $2.00 to $2.50 per kilowatt, and the room occupied is practically none at all.

In contrast to this is the experience of the unusually large condenser and auxiliaries usually found in turbine plants which, by comparison with the diminutive turbine, appear unduly prominent. Aside from the type installed by Mr. Rockwood there are three other accepted designs for turbine condenser plants:

1. The combination of a surface condenser, a centrifugal hot well pump, an air cooler, a single-cylinder dry vacuum pump, a centrifugal circulating pump with their connecting drip piping and valves.

2. The same arrangement, but with the hot well pump, the air cooler and dry vacuum pump omitted, substituting therefor the wet vacuum pump—preferably of the Edwards type. The cost of these two equipments is about $7.00 to $10.00 per kilowatt.

3. An equipment like the first, except that an elevated jet condenser with a barometric tube and hot well takes the place of the surface condenser and hot well pump. This takes up less floor space and costs but $5.00 to $6.00 per kilowatt. The dry vacuum pump used with barometric condensers must have a two-cylinder air pump, and the exhaust from the turbine cannot be used again in the boilers.

The author contends that the injector condenser would seem to bar out all other condenser systems in situations where the water is pure. For example, if the city water is pure and costs about seven cents per 1,000 gallons, water enough for a 400-kilowatt machine at 100 per cent load factor would cost per factory year of 310 days, 10 hours a day, at 1,000 gallons per hour, about $217. With interest at 5 per cent and fixed charges at 8 per cent this sum warrants the capital expenditure of not to exceed $1,670. It is thus clear that it does not pay to buy the surface condenser system simply to save the cost of paying city rates for boiler feed-water. Where the feed water contains salt, sulphate of lime, acid, grease or other hurtful pollution, however, then it pays to use one of the surface condenser systems.

Much talk has been made about the freedom of the condensed exhaust steam in turbines from cylinder oil, and the advantage which this purity gives to it as compared with the oily exhaust from reciprocating engines, where the condensed steam is returned to the boilers.

It should not be forgotten that great purity of feed water is not in itself a desirable thing, being only better than very impure water; for it pits the tubes and water legs of steel boilers, unless some lime is added. Where the waste injection water from a jet condenser is used for washing in a dye house, this freedom from oil is a great advantage. Such is the aversion of dyers to using exhaust steam to heat water on account of the supposed presence of cylinder oil—no matter how careful one may be to provide, and operate successfully, oil eliminators—that this freedom of the turbine from the use of cylinder oil is sufficient cause to determine the purchase of turbines in place of engines for power in such places.

The method of sealing the spindle of the Parsons turbine against air leak where it passes out to its journals from the low-pressure chambers, namely, by pumping water with centrifugal pumps formed in small recesses in the shaft cover, so as to keep a water pressure in these recesses in excess of that of the atmosphere, is a perfect success.

In starting the turbine at the Atlantic mills, injection water is first turned on, then steam is admitted to the turbine without admitting water to the air seals where the shaft passes through the turbine casing. After the load begins to come on, the drip pipe from the exhaust chamber to the atmosphere, which has been open all night and up to this point, is now closed, the water turned on to the air seals, and the vacuum immediately draws down to 28 inches. It is not found absolutely necessary to start in this way, as the turbine can be run hours before the water accumulates in quantity. The object is simply to drain the turbine up to the moment when the load begins to come on.

It is necessary to exclude any accumulation of water in the exhaust pipe for fear that it will sway back and forth until it flushes up on to the large low-pressure blades of the turbine. Running as they do at a very high velocity, sudden contact with water from the exhaust pipe will strip the last row off clean if such contact is permitted. Any further damage, however, to the other rotating blades seems to be prevented by the presence of the fixed row, which, by dividing up the water into small streams, seems to protect the moving rows from contact with solid water and therefore from injury. It is not, however, necessary to provide a drip pipe or drip pump, for removing the water of condensation or the leakage into the exhaust chamber from these air seals.

DIAMOND TOOLS.

Abstract of Paper by G. C. Henning, presented at the Meeting of the A. S. M. E., December, 1904.

Steel is, of course, the one material in almost universal use for cutting and working stone, metal, wood and other materials, because of its great strength and the degree to which it can be hardened. There are some materials, however, which, because of their hardness, structure or non-conductivity of heat, cannot be worked economically by means of steel tools. The latter become worn rapidly, losing their shape and dimensions to such degree and extent that the work produced becomes inaccurate, causing constant interruption of operation, loss of time, and the use of new tools or frequent regrinding or shaping of the old ones. This causes great expense and delay in production. The great friction produced by cutting materials in some cases draws the temper of steel tools, making them useless. Hard rubber, paper and hardened steel cannot be readily worked by use of steel tools, as is also the case with hard stone. In these cases a much harder material is required, and for this reason diamond is used. The diamond used is of two kinds, totally different in appearance and quality. 1. The black diamond has a very dark purple brown color, and is an amorphous, granular stone with rarely any crystallization visible or traceable. It is called carbon or black diamond. It is the hardest material known and has great strength. 2. Bort, is entirely crystalline, and is generally transparent and of all colors of the rainbow, as well as clear and transparent as glass. The latter is considered of greater hardness than all other bort except some which is almost black. Bort is extremely brittle and is readily fractured or "cleaved" in the three directions of its cleavage planes parallel to the sides of the octahedral crystal, in which shape it is most commonly found. The dodecahedral crystals are also readily cleaved in a similar manner.

In spite of the very great hardness of all kinds of diamonds, they are readily sawn, drilled, cut and polished; carbon (black

diamond) cannot, however, be polished, as is the case with bort.

Diamond cuts diamond, while steel saws and drills, and cast iron discs charged with diamond dust are used for the other operations. All kinds of grinding wheels, being made of extremely hard materials, are most readily kept free from filling or glazing and in perfect shape by diamond tools. In certain classes of work, where great accuracy and precision are primary requirements, or extremely fine lines are essential, the diamond is the only material that answers the purpose. Thus lithographers, engravers and scale-makers use them for fine work. Another very important field of production in which diamond is all but imperative to obtain satisfactory results at reasonable cost is that of wire drawing. Formerly all small wire was drawn through holes in hardened steel plates, but these wear so rapidly that the wire soon loses its caliber and becomes unround. As it is all-important, especially in electric work, that the wire be of absolutely uniform size, so as to maintain constant resistance and permit symmetrical distribution of weight about spindles and shafts, it became necessary to use a material harder than steel, and hence diamond was again resorted to. This made it possible to avoid delays in replacing worn dies, and because of the great permanence of accuracy of the calibers of the holes in the diamonds, the cost of producing fine wire of copper, brass, steel, iron, nickel, and of other metals was materially reduced.

It is, of course, well known that stone is drilled and sawed by the use of diamonds, these having been used in core drills, which, in an extreme case, have cut solid cores of about 21 inches diameter. In diamond drills, stone saws and grinding wheel dressers, the rough diamond is used in appropriate holders, set either by staking, brazing, soldering, or by casting molten steel around the diamonds. A peculiar property of the diamond is that it can be plated like any metal; this property is made use of in the galvanoplastic setting. The galvanoplastic setting consists in first plating the diamonds and then casting other molten metal around them, which alloys with the deposited metal. Thus an absolutely firm and rigid setting is produced.

Very high temperature does not affect the diamonds either in their hardness or, when sound, in their solidity, and does not produce checks or other flaws. A temperature higher than that sufficient to melt steel will, however, burn the diamond, and that of the electric arc will do so readily. The diamonds in tools used for doing accurate work are, however, all "shaped" by cutting and polishing, so as to imitate the customary shapes of steel tools.

Glass and china are also drilled by shaped diamonds, in which case a triangular splint is generally provided with a flat triangular pyramidal point, which, when using turpentine as a lubricant, penetrates glass and china more readily than any other tool, and lasts for from one to two years, unless broken by carelessness or accident. There are various styles of tools. In the round-nose tool, the diameter or curve of cutting edge and its clearance from a right angle can be produced at will. In the sharp-nose tool also the angles can be varied at will. The square-nose tool is used mainly for producing very high finish of hard rubber, and a tool commonly used for turning paper calender rolls, which must be very accurate and smooth, consists of a piece of black diamond shaped as a round-nosed tool, and simply clamped in proper position between two pieces of steel. The last three tools are most commonly used for turning hard rubber, because the diamond lasts a very long time without wear and produces absolutely smooth and accurate work, while steel tools wear off in a few minutes at most and get very hot. One other reason why it is economically advantageous to use diamond tools for turning hard rubber is that very high speeds can be used, 450 to 500 feet per minute being common.

It may here be added that diamond tools are most suitable for working carbon used for electrical purposes.

A diamond die used for drawing wire consists of a bronze block in which is set a diamond perforated by a tapering, polished hole through which the wire is drawn. The holes in these diamonds are rarely made larger than .064 inch diameter, because steel draw plates or dies are considered sufficiently accurate and economical for larger sizes, and [illegible] great cost of diamond dies. The smallest di[illegible] come to the notice of the writer had holes of .001 in[illegible]ter, although clients have called for calibers as sm[illegible] .00055 and .00065. It is common practice to make the [illegible] in diamond dies accurate to .0001 inch, which to many e[illegible]neers may seem almost impossible, and is therefore here mentioned. In drawing copper wire, it is customary to draw a .061 wire in one pass from a rough wire of .072 diameter. Smaller sizes are then produced by the following consecutive reductions: to .053, .045, .040, .036, .032, .028, .025, .022, .020, .019, then by 1-1000 down to .0075 and by half thousandths down to .001.

It may be mentioned that diamonds wear increasingly when drawing the following metals in the order stated, viz.: gold, silver, copper, brass, bronze, platinum, soft steel, nickel, iron and crucible steel (piano wire).

In order to show why such expensive material as diamond can be used economically it may be stated that diamond dies wear up to eight years under constant use. One die of .004 caliber has, according to the record drawn over 550,000 pounds of soft copper wire. Diamond drills for drilling glass wear from one and one-half to two years before requiring recutting.

As is well known, diamonds are also used for spindle bearings in watches, and most recently have been introduced as cupped bearings for the pivots of electric meters, because they produce the minimum of friction, and do not wear out in many years. Another purpose for which diamonds are used is that of drilling teeth, especially artificial teeth. In these drills minute chips of diamonds soldered into steel shanks are used. These diamonds are not prepared in any manner, as their points and edges when properly selected are sufficiently hard and sharp to penetrate bone and porcelain. The shapes of chips most generally used are flat, triangular points and three-sided pyramids. The most perfect drills for this purpose have diamonds of triangular sections with a pyramidal polished point.

THE BURSTING OF FOUR-FOOT FLYWHEELS.

Abstract of Paper by Prof. C. H. Benjamin read at the December 1904, Meeting of the A. S. M. E.

Prof. Benjamin has continued his destructive work of bursting flywheels, for the benefit of the engineering public, by running some tests of this character upon flywheels four feet in diameter. To insure safety to the students and to the building of the Case School of Applied Science, these tests were conducted outdoors, in consequence of which they nearly proved disastrous to the neighbors. The flywheels were run in a casing of steel castings, located in a pit lined with brick. The flanges of the lower half rested on brick piers and were bolted in place. The entire upper half of the casing could be hoisted up, giving access to the interior for hoisting or removing the wheels. Two wheels were broken successfully, but the third one burst through its bounds and carried the casing with it many feet in the air. Fortunately every precaution for safety had been taken, all the observers being located far away from the plane of rotation of the wheel. These interesting experiments are to be continued, but hereafter the wheels are to be mounted on a vertical shaft and are to run in a pit in the ground, so that however great the violence with which the wheels go to pieces no possible harm can be done.

In carrying out these experiments the shaft supporting the wheel to be tested turns in bearings bolted to angle irons on the lower halves of the side plates, and was connected to the driving mechanism just inside the building by a flexible sleeve coupling. After the wheel was in place, the casing was lined with wooden blocks to absorb the momentum of the flying fragments. Instead of using a steam turbine as in former experiments, the flywheel shaft was speeded up by means of a Reeves variable speed countershaft, interposed between line-shaft and the driving-shaft.

The first wheel to be experimented on was a well-proportioned cast-iron pulley, such as is used on shafting for transmitting power. This pulley was 48 inches in diameter, had six arms and weighed 191 pounds. The rim was whole and was $8\frac{1}{2}$ inches wide and about $\frac{3}{8}$ inch thick, finished on

the outside. The arms were elliptical in section, 3⅛ inches by 1 1-16 inches at the hub, and 2 inches by ¾ inch at the rim. On the whole the wheel was well-designed and showed no signs of shrinkage strains. It had, however, been balanced in the customary manner by riveting a cast-iron washer inside the rim at the lighter side, and this proved its undoing. The combination of a thin place in the rim, a rivet hole and a heavy mass of cast-iron, is enough to wreck any wheel.

As has been shown by previous experiments on whole rim wheels of cast-iron, a bursting speed of 400 feet per second may be reasonably expected. The circumference of a four-foot wheel being about 12½ feet, such a wheel should burst at about 32 revolutions per second, or 1,920 revolutions per minute. The pulley in question burst at 1,100 revolutions per minute, as recorded by a tachometer connected to the driving-shaft. The balance weight weighed 3½ pounds, and its center was approximately 23 inches from the axis of rotation. At 1,100 revolutions per minute the centrifugal force of the balance weight alone would be 2,760 pounds. Add this radial pressure at a weak point between the arms to that due to the weight of the rim itself, and the low bursting speed is easily accounted for.

The linear speed of the rim at rupture was 230 feet per second. As 100 feet per second is considered the limit for belt speed, this pulley would have a working factor of safety of $(2.3)^2$ or 5.3. But suppose the rim had been a little thinner and consequently a bigger weight had been put on with a larger rivet?

Wheel No. 2 was a cast-iron pulley of the same general style and dimensions as No. 1, but with a split hub and rim. The balance-weight was present here as in the former case, but was obliged to yield the palm to its rival, the flanged joint. The wheel had been cast in one piece, as is usual in such cases, with cavities cored at the joints of rim and hub.

After finishing it had been broken apart by wedges, making a fracture joint. The flanges, being located midway between the arms and bolted at some little distance inside the rim, were in the worst possible position to withstand the bending action due to centrifugal force, and their own weight only aggravated the difficulty. The flanges weighed with their bolts 7½ pounds. This wheel burst at less than 700 revolutions per minute, the tachometer not recording below this speed. The writer believes the speed to have been about 600 revolutions per minute. At this speed the centrifugal force of the flanges on one side would have been 1,680 pounds. At 600 revolutions per minute the linear speed of rim would be only 125 feet per second. At the very common belt speed of 4,500 feet per minute the factor of safety would have but 2.8, which is altogether too low, considering the nature of the material and the shocks to which a pulley may be exposed.

There is one instance on record of the wrecking of an engine by the breaking of a generator pulley, which had a heavy balance weight inside the rim.

It was reserved for wheel No. 3 to develop the most dramatic series of incidents of any yet experimented upon, big or little. This wheel measured 49 inches in external diameter and weighed about 900 pounds. The rim was 6¾ inches wide and 1⅛ inches thick, and was built of ten segments, the material being cast-steel. Each joint was secured by three prisoners of an I-section on the outside face, by link prisoners on each edge, and by a dove-tailed bronze clamp on the inside, fitting over lugs on the rim. The arms were of phosphor bronze, twenty in number, ten on each side and were a cross in section. These arms came midway between the rim joints and were bolted to plane faces on the polygonal hub. The rim was further reinforced by a system of diagonal bracing, each section of the rim being supported at five points on each side, in such a way as to relieve it almost entirely from bending. The braces, like the arms, were of phosphor bronze, and all bolts and connecting links of steel.

This wheel was designed by a Baltimore firm as a model of a proposed 30-foot flywheel.

On account of the excessive air resistance it was found necessary to enclose the wheel at the sides between sheet-metal disks, before any great speed could be attained. Even then repeated trials failed to reach a speed of more than 800 or 900 revolutions per minute on account of the great inertia of the wheel, and the consequent slipping of belts. But putting on more and wider belts, by a liberal use of "Cling-Surface" and with the aid of a 7½ horse power electric motor belted on in parallel, it was found possible to get a speed of 1,650 revolutions per minute, and after the wheel had been run at this speed it was stopped and examined.

The inspection showed fracture of several of the I-shaped prisoners on the outer surface of the joints and a slight opening of the joints themselves, to the extent of perhaps one or two hundredths of an inch. On June 2, 1903, the casing was closed for the last time, and the combination of driving mechanisms set to work. The observers were all well protected by the thick piers of the building, while other spectators were kept at a safe distance and well away from the plane of rotation. Two of the observers watched the pointer of the tachometer through opera glasses, another kept the time, while a fourth manipulated the driving levers.

As the hand of the speed counter reached and slowly passed the 1,600 mark, the feeling of suspense on the part of those watching reached the acute stage. The pointer crept slowly on and as it quivered on the mark of 1,775, there was a sudden crash, a sound of rending and tearing, and the writer saw the countershaft inside writhing on the floor like a wounded snake. On stepping outside he was saluted by a shower of falling splinters and fine debris, and was surprised—putting it mildly—to note the disappearance of the greater part of casing and wheel.

The steel rim of the casing was broken off short, six inches below one of the flanges, and the entire upper half weighing half a ton was projected about 75 feet into the air and landed some hundred feet away on the campus. On its way up it carried away part of the cornice of the building, and this collision was probably what caused it to deviate so much from a vertical path. The hub and main spokes of the wheel remained nearly in situ, but parts of the rim were found two hundred feet away, while one large fragment landed on the roof of the building.

This sudden failure of the rim casing was unexpected, as it was thought the flange bolts were the parts to give way first. The tensile strength of the rim at the point of fracture was about 1,200,000 pounds, or about four times the strength of the wheel rim at a solid section. Examination of the break in the casing showed a clean, bright fracture, with almost no imperfections.

The failure of the wheel itself was due to a gradual opening of the joints, occasioned by the fracture of the outside prisoners, and to flaws in the bronze castings of the arms near their junction with the rim. On putting the pieces of the wheel together in their original order it was easy to locate the joint which first gave way, on account of the symmetry of the breaks either side of a diameter through this point. It is but fair to the builders of the wheel to say that the fractures showed uniformity of strength and of workmanship, since there was hardly a member or a joint which did not fail in one part or another of the wheel.

One thousand seven hundred and seventy-five revolutions per minute means a linear speed of rim 22,300 feet per minute, or 372 feet per second. This is not as great as the probable speed of a solid cast-iron rim of good design, but it is greater than the speed of any sectional or jointed rim which has been tested. The tensile stress due to the centrifugal force at this speed is 13,800 pounds per square inch. This shows that the joints were much weaker than the solid rim. On the whole, the test of this particular wheel was disappointing, since its strength was not sufficient to repay one for the expense of the design.

It is interesting to compare the kinetic energy of the rim of the wheel at the recorded speed with the work of destruction. Assuming the rim with its lugs, flanges, etc., to weigh 300 pounds, which is a reasonable estimate, the kinetic energy at a speed of 372 feet per second would be 645,000 foot pounds. Further assuming that none of the energy was dissipated in heat, and that the combined mass of wheel and casing projected into the air weighed 1,500 pounds, we find the height of projection to be 430 feet. It is good cause for congratulation that four-fifths of the energy *was* dissipated.

STAYBOLTS, BRACES AND FLAT SURFACES.

December, 1904, Meeting A. S. M. E.

In a paper upon staybolts, braces, and flat surfaces, Mr. R. S. Hale compares the various rules for working stresses in staybolts, pointing out that in short bolts a bending action occurs which is more destructive than in the longer bolts. He also compares various rules for the strength of flat surfaces, and gives a table containing figures upon cases where bulges in boiler plate have occurred between staybolts. His general conclusions are as follows:

Stress on Stays.

Comparison of the various rules for working stress on stays and braces shows a general neglect of the difference between long and short stays. For the long steel stays, subtracting ⅛ inch from the diameter, and then allowing 12,000 pounds per square inch on net section, remaining gives results which apparently will be better than any of the present rules. For iron stays probably 10,000 should be used. For short stays, which are chiefly iron, where bending action comes in, empiric rules reducing stress as length of stay decreases may be used. Our knowledge of the bending stress is not sufficient to warrant the use of a more theoretic formula

Pitch of Stays and Thickness of Plates.

Comparison of the working pressures for pitch of stays and thickness of flat plates shows that the complicated formulas of some of the rules do not give as good results as the simpler formula $P = C \frac{t^2}{p^2}$, C being taken as 100 to 115 for riveted stays, 140 for stays nutted or crowfoot stays riveted on, and a higher value up to 200 or 250 for the use of washers or channels or angle bars riveted on; P = steam pressure; p = pitch of staybolts in inches; and t = thickness of plate.

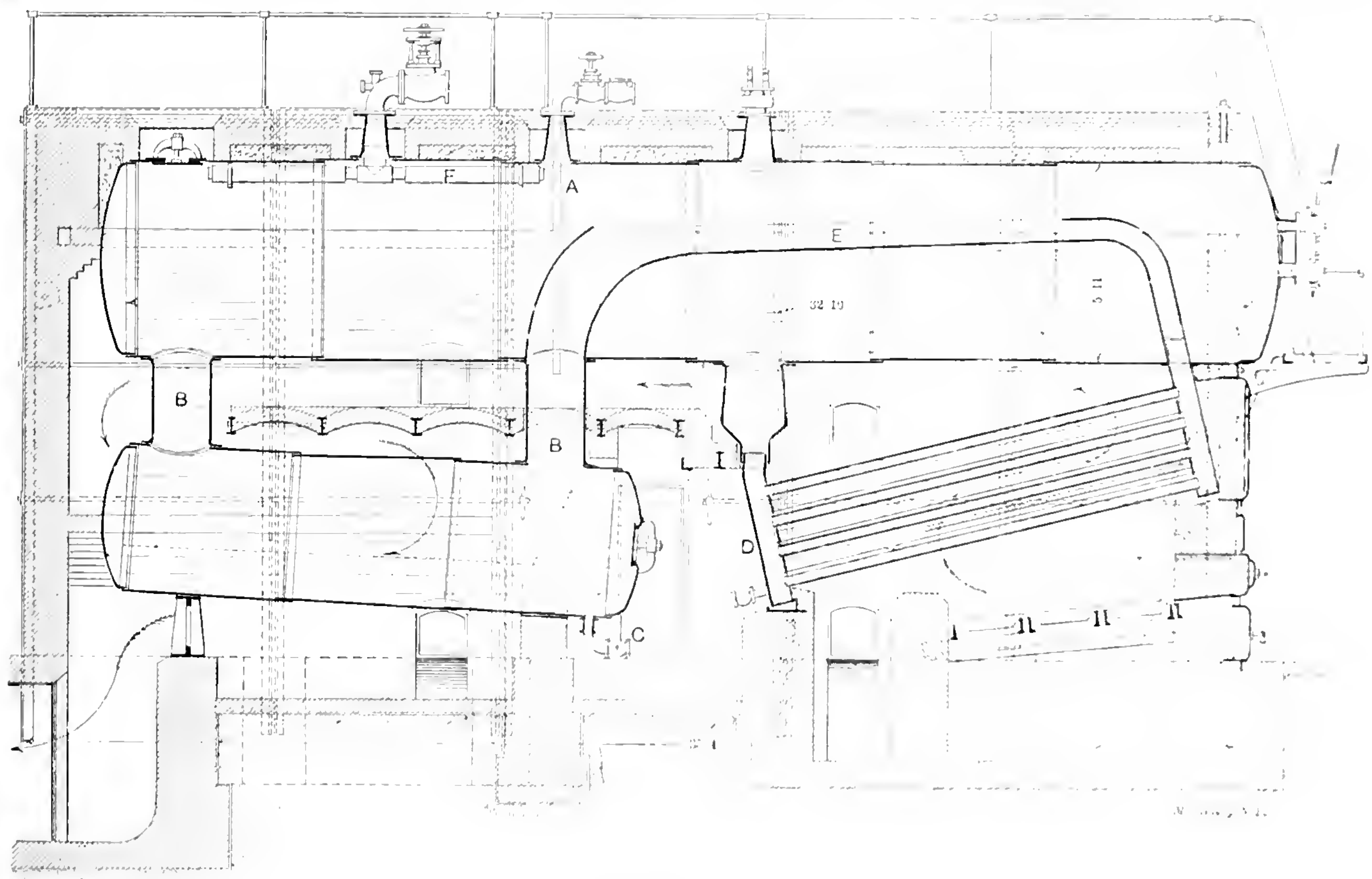
If the pitches differ by less than 20 per cent use the surface instead of p^2. If the pitches differ by more than 20 per cent it is a special case. Special cases and unusual construction must always receive special consideration.

The above constants give results indicating the probable safe pressure for a year or so, until the next examination. In designing a boiler for a long life the constants should be reduced by some 20 per cent or so, just as a factor of safety of 4 can sometimes be used temporarily for the shell of a new boiler, while 5 should be used in designing a [illegible] to be run for a number of years without reduction of pre[illegible].

LARGE WATER-SPACE WATER-TUBE BOILER.

Der Praktische Maschinen Konstructeur, July 7, 1904, p. 106.

This boiler, which is exploited by the Rhenish Steam Boiler and Machine Works, has a claim of extra high efficiency of evaporation given it by its builders. The accompanying illustration shows that it is a compound of water-tube and cylindrical types with a special circulating apparatus. The water tube section is at the front and closely resembles the Babcock & Wilcox type. At the rear of the rather long shell there is a mud drum placed beneath and in the passage of the gases as they come from the furnace. This mud drum is connected to the upper shell at two places and at the forward end it leads into a trough extending along the upper surface of the water to which the front header of the water-tube section also leads. This is intended to facilitate circulation. The course of the gases of combustion is up through the water-tubes, thence back beneath the water drum to the rear where they turn forward to pass over the top of the mud drum to finally turn back beneath the latter and escape at the flue



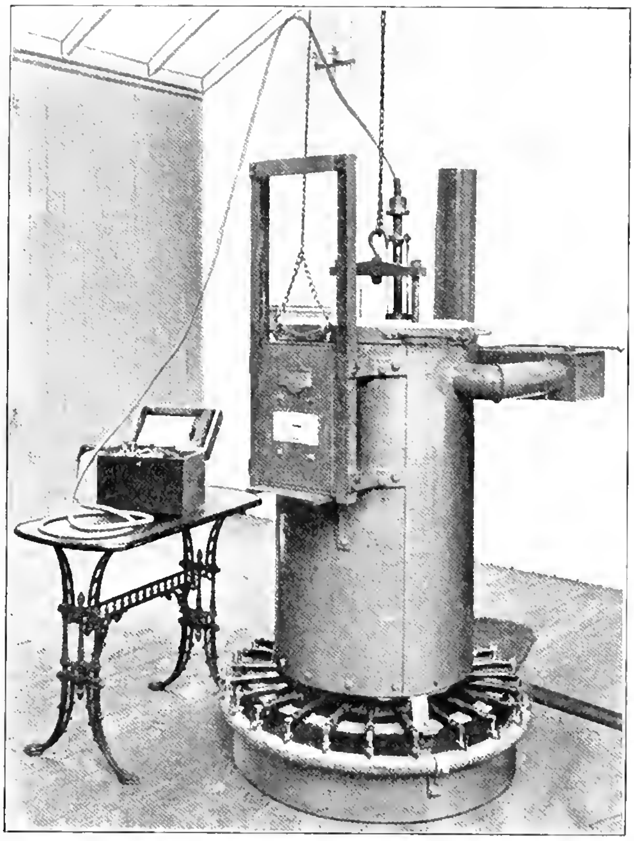
Large Water Space Water-tube Boiler

The circulation of the water is as follows: The feed is introduced through the top of the upper shell by means of the pipe A, which leads down to near the bottom of the same and over the forward connection of the mud drum. The water, on leaving this feed pipe, sinks down through the connection into the mud drum, where the blow-off cock C is located, and there it flows back to the rear end of the drum. Having become somewhat heated by the spent gases in the flue it rises through the connection B into the upper drum, where it is still further heated. In this condition it flows down through the connection into the back header of the water-tube section D, and streams from there out through the nest of tubes. Here it is partially evaporated and the mixture of steam and water issues from the front header through a connection, as shown, into the trough E, where they are separated. The water again drops down through the connection B' into the mud drum while the steam is stored above the water level. When the throttle is opened and the steam is drawn off, the trough F serves as a sort of steam separator. G. L. F.

A NEW HARDENING FURNACE.

A hardening furnace with a number of features of interest has been in operation at the New York offices of Geo. Nash & Co., dealers in iron and steel. It is a furnace made under the Brayshaw patents, the United States rights for which have been secured by this company, who are now in a position to place the furnace on the American market.

The contention made by the inventor is that the treatment of tool steel cannot be accurately regulated in an open furnace. In order to know what is being done it is necessary to immerse the steel in a liquid the temperature of which can be accurately determined. Mr. Brayshaw has experimented extensively with lead, but he considers a salt bath to be superior, and has patented a composition for such a bath. The operation of the furnace is based upon the well-known laws of the heating and cooling of steel, which are in no way a secret, but on the contrary well understood by metallurgists. If, for example, a piece of tool steel is gradually heated, the



Hardening Furnace and Pyrometer.

heat being supplied at a uniform rate, a point will be reached called the absorption point, at say 725 degrees C, or thereabouts, where the rise of temperature will be more gradual for a few minutes. After that point is passed the rise will then continue at about the same rate as before. In cooling, the temperature will drop regularly until the point of recalescence is reached, when the temperature for a few minutes, will not only cease to drop but will actually rise a slight amount. After passing this point, however, the drop in temperature will gradually resume its former rate. A peculiar fact is that this point of recalescence is lower by several degrees than the absorption point. In the specific case mentioned above it is about 700 degrees C, instead of 725. Mr. Brayshaw finds that it is impossible to harden steel at any point below the absorption point. For good hardening the temperature must be raised so that the absorption of heat is complete; but when this has been done the temperature may be lowered very considerably, so long as recalescence does not begin. In the case mentioned above, if the steam is first heated to above 725 degrees C, and then is allowed to cool down to nearly, but not quite, 700 degrees, it will still harden perfectly. He also finds that by adopting this method of heating carefully to a point above the absorption point, and then lowering the temperature, it is possible to harden steel at a very low point.

The object in designing the furnace was to take advantage of the above principle. A crucible is hung inside of the furnace for holding the liquid bath. The gas flames, coming from the Bunsen burners beneath pass up and around the crucible and heat it, and also the bath and the inner lining of the furnace, to a temperature determined accurately by a pyrometer, which is always in the bath. The pyrometer is read by means of a Whipple temperature indicator which operates on the principle of Wheatstone's bridge. The perforated metal tray can be raised and lowered inside the furnace, and pieces of the work placed inside the tray can thus be dipped into the bath or raised out of it without subjecting them to any change in temperature since the walls of the furnace are substantially at the temperature of the bath. Obviously, since it has been desirable to work between such narrow limits of temperature the heat of the furnace must be regulated carefully and this is done by watching the recording instrument and by adjustment of the main supply pipes for the Bunsen burners. In case of complicated cutters and other tools they can be heated up gradually in another furnace, if desired, before dipping in the bath, so the thin parts of such cutters will not be suddenly heated up to a high point before the heavy parts are heated. When placed in the bath the temperature is allowed to rise to what is known to be the correct point, assuming that any particular brand of tool steel is fairly uniform in character, and then the temperature is allowed to drop until the point is reached where the work is to be removed and plunged in the cooling bath. It is claimed that most complicated work can be hardened with little or no trouble by this means, and that results are very uniform.

* * *

THREAD DRAWN FROM MELTED QUARTZ.

The investigations of physicists generally require apparatus of the greatest possible refinement, and oftentimes it must be developed to a degree of sensitiveness hitherto unknown. Some years ago it was found imperative to discover a fiber for the suspension of certain parts of a bolometric apparatus used in the determination of the amount of heat received from the stars, that should possess properties found in no material then available. The fiber or thread required was to be used in supporting part of the apparatus subjected to very minute torsional force. Fibers of silk or steel or any known substance did not fill the requirements, inasmuch as they are unstable and do not possess the absolute perfect springy qualities necessary to return the needle to zero every time it is displaced. Moreover, it was necessary to find a fiber of the utmost tenuity which possessed the required qualities. Professor Boys experimented and discovered that melted quartz could be drawn into fibers of extreme tenuity, having an almost perfect torsional elasticity, if the operation could be done quickly. This requirement was satisfied by spinning the molten quartz from the pot by attaching it to an arrow which was propelled from a pine bow. Thus apparently one of the most unpromising substances for the support of delicate deflecting apparatus proved to be an almost ideal material. Lately it has been discovered that soapstone when highly heated can also be drawn into fine fibers possessing all the qualities of elasticity and resistance to chemical action characterizing the quartz fibers.

* * *

WALTER KIMBALL, OF RICHMOND, VA.

Last month an individual writing under the name of Walter Kimball, from Richmond, Va., with a letter-heading giving his business in machinery and tools, inserted an advertisement in this paper offering a number of standard machines at absurdly low prices, which caused considerable inquiry among the trade; several orders having been sent, and in one case a remittance made to cover the purchase. None of these orders was filled, and careful search in the city of Richmond failed to discover any person of that name in the machinery trade in that city. Further investigation shows that on November 26, last, he rented a room in a private residence at 315 E. Main Street, Richmond, where he roomed until the 14th of December, when he left without notice to the lady of the house, or giving any information concerning his whereabouts.

JIG AND MILLING FIXTURES WITH OPERATION SHEET.

B. P. FORTIN.

The accompanying drawings show jig and milling fixtures, and the operation sheet, Figs. 1 and 2, is also included as being of interest in connection therewith.

In my article of August, 1904, I described some of the obstacles to be met with in jig designing. Now some of these same difficulties are encountered in milling fixture construction—in fact, all of them except the need for lightness of fixture. First, as with drill jigs, they must be so designed as to be easily cleaned of chips, and to prevent possibility of work being put in in the wrong way. Another very important thing is the springing of work. Rough castings give the greatest trouble, and it often requires considerable thinking to design a fixture to clamp a delicate casting without springing it. Milling fixtures should have ample stock in the right place, to insure stiffness and a smooth cut. The cutter used should be as small as possible and close to the spindle, unless supported by the overhanging arm.

The operations for the job were gotten out in this manner: The name of casting to be operated on is called "gear rack take-up," and this name was printed on the outside of a double sheet of paper, 9 inches by 6 inches, Fig. 1. The name can be written or printed, but the best plan is to have the sheets typewritten on bond paper, and the prints taken from them. The sheets can then be placed in some commercial cover; one that is arranged so the sheets can easily be changed whenever a change is made is the best. Each cut or hole has a name. On the inside of the sheet, on the left hand side, Fig. 2, are the names of different cuts and holes, and on the right-hand side, opposite each operation, are the names of the jigs or fixtures and the tools used; also the kind of machine that they should be used on. The extreme right gives the sheet number of drawing and stock tools.

The drawing room and the manufacturing department each have a set of these sheets. Whenever a new job is started, by consulting the operation sheet, it is easily found whether the particular machine wanted for the job is in use. After finding this out, we next look at the operation to see what tools are wanted, and in making our wants known to the toolroom keeper, all the tools pertaining to this job are handed out. Each jig or fixture, with its tools, is kept in separate bins and is easily found.

LIST OF OPERATIONS AND TOOLS.

No. P. 14 Machine.

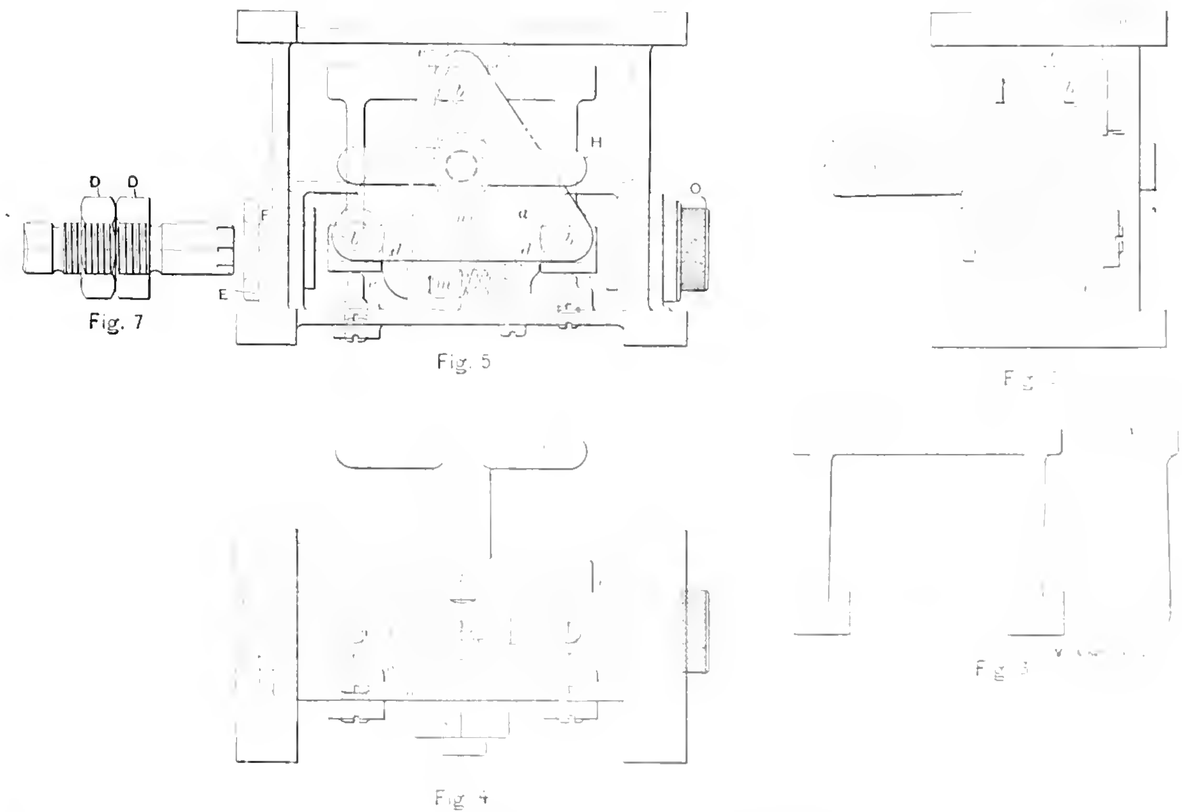
NAME OF PART.

GEAR RACK TAKE-UP.

Fig. 1. Outside or Title Page of Operation Sheet.

	Operation		Tools.	Sheet No.
1	Clean Casting			
2	Drill shaft holes	2	Jig on Slate four-spindle drill	P 14-T-1
			1-4 Starter Drill	Stock
			7-32 drill	"
3	Square hubs	3	Special end mill	P 14-T-2
4	Finish ream shaft holes	4	1-4 Rose reamer	Stock
5	Mills for rack slide	5	Milling fixture on B & S No. 0 milling machine	P 14-T-3
	Roughing cuts for rack seat and finishing face		Gage cutters. Set fixture on base marked A	P 14-T-4
	Finish cut on rack seat		Special bevel cutter Set fixture on base marked B	P 14-T-5

Fig. 2. Operation Sheet



Jig with Equalizing Clamping Device for Rough Castings

In this particular case the drilling was found to be the most convenient operation to perform first. Fig 3 shows the casting with a ¼-inch reamed hole through opposite hubs, and milled at the points indicated by f. Figs. 4, 5 and 6 show side, plan and end views of the jig with the work therein. The casting rests on the rigid gage point b and two adjustable points b^1 b^1, and is pushed against the two adjustable gage points c c, Fig. 5, by the spring c; d is a rigid gage point sideways, which takes the thrust of drilling, and the end mill. d^1 is a spring pin which pulls the work against the rigid point d, and it also takes the thrust of drilling and end milling. The clamp a has three pins h, h^1 h^1 which are in line with gage points b b^1 b^1, for clamping points. Stud j extends through the bottom of jig into the strap k, which takes the pull of the hand nut l. Strap k rests on a solid seat, on one end, and the other end rests on the pin m, which is in direct line with the spring pin d^1. The upper end of m has a slight angle to prevent the slipping of d^1. Therefore, by screwing down the hand nut l the force is transmitted through strap k to pin m, and thus clamps the work and the spring pin d^1 simultaneously. O is a slip bushing, which is also used on the opposite side; n is a pin extending through a to prevent the turning of the clamp when screwing the hand nut l; Fig. 7 is the end mill for facing the hubs; and D D are adjustable nuts used as a stop against O. As the distance from one finished surface of hub to the other had 0.01 inch limit we had no trouble in getting them inside of that figure.

The milling fixture is shown in views Figs. 8, 9 and 10. This fixture is designed for two positions at right angles, or in other words, there are two separate operations to be performed, one from each base A and B, Fig. 10. The reason for this is that when the fixture is set up on machine platen, on base A (as will be seen in operation) a gang mill is used which furnishes surface a and b, Fig. 3, and roughs out the slot for the dovetail. Now, if this operation were performed in the other position B (B is the base the fixture stands on when finishing dovetail slot) it would be necessary to make these cuts do the same amount of work that is done with the gang mill in one; therefore it is readily seen that it makes considerable difference in cost of piece what kind of cutters are used. The casting is located from the shaft hole by the stud C and spring pin D. The idea of a spring is that it has a certain pressure not great enough to spring the casting, but sufficient to push the pin into the hole and the work against the shoulder on C. The casting rests on rigid gage point E which has the same relative position to fixture as d, Fig. 5, has to jig. The center clamp F forces the work against the rigid gage point E; the two end clamps G and H are made to float and locate to casting and are locked in place by J and K. M is a gage for setting the cutter. The numbers on the screws indicate the order in which they are to be screwed up. Fig. 11 is the bevel cutter for finish-milling dovetail slot or rack seat.

* * *

MAKING DROP FORGING DIES.

C. W. SHELLY.

Young machinists, who have never seen drop forgings made, may be interested in the following general description of the work:

The dies are made of .45 to .60 carbon steel, and are, usually, from 5 to 8 inches thick. Fig. 1 gives a general idea of their appearance when finished. They are marked T and B (top and bottom) to prevent their getting mixed up in the laying out. The front and left-hand sides are squared up, and from these sides the center lines of the impressions are laid out and the dies set up when ready for use. The edger, or breaking down impression, is on the right-hand side of the die. It is for breaking down the rough heated stock into something like the shape required, before it goes into the finishing die. Sometimes a separate breaking-down die is used. The heaviest part of the forging is always nearest the front. In deep dies, shapes which show parallel sides on the drawing, are given from 5 to 7 degrees taper on each side, to prevent the forging from sticking in the die. For machining the forging 1-32 inch is usually allowed, and for shrinkage, .012 to .015 per inch. When the dies are finished a

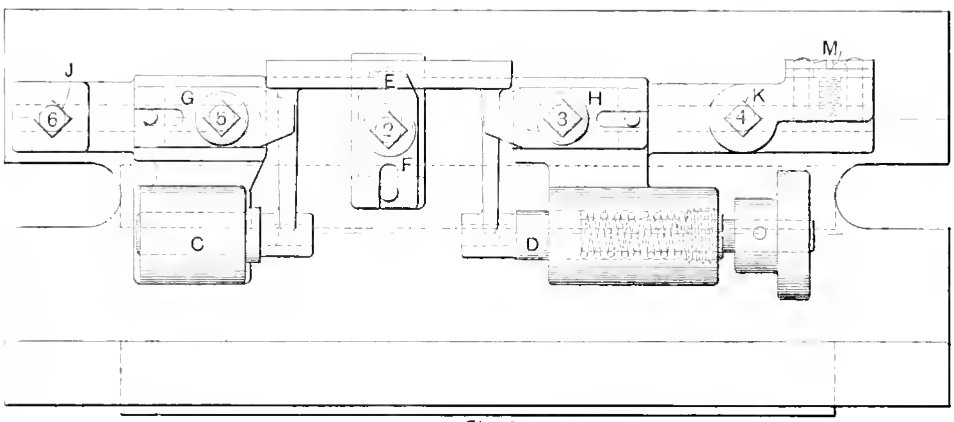


Fig. 9

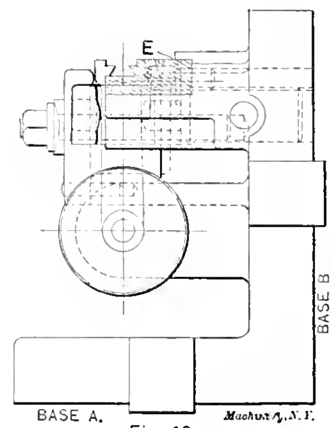


Fig. 10

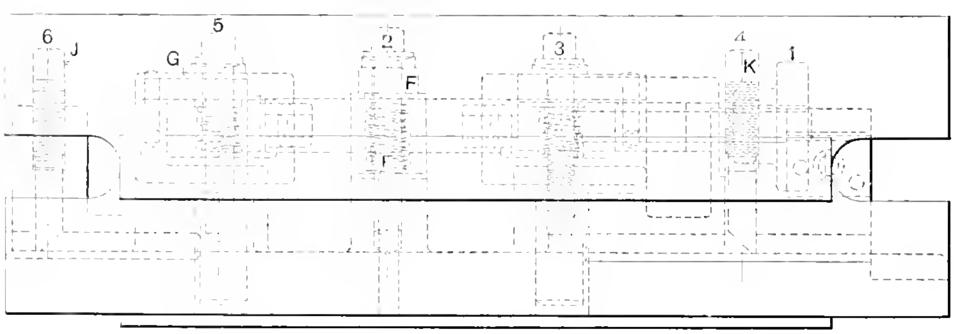


Fig. 8

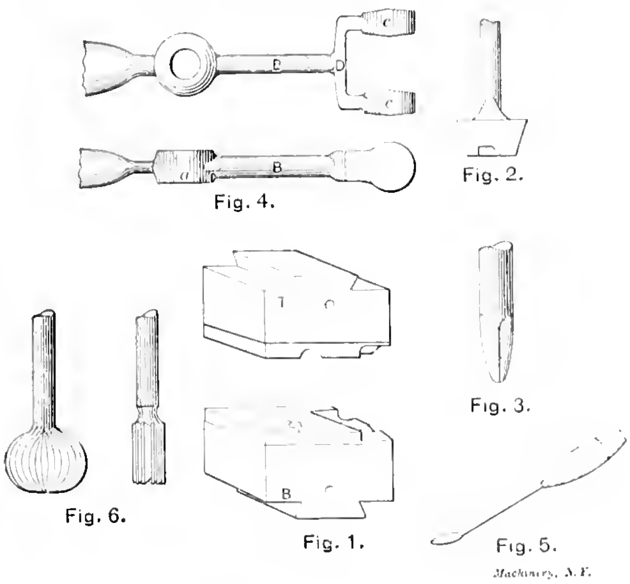
Fig. 11

Milling Fixture for Rough Castings.

C. W. SHELLY was born at Berlin, Ontario, Canada, 1879, and received a Canadian high school education. He served an apprenticeship with the Canadian General Electric Co. at Peterboro, Ont., and has since worked for the General Electric Co., in Lynn, Mass.; the Richmond Electric Co., the Stanley Electric Co., the Hope Mfg. Co., J. H. Williams & Co., etc. He is a tool, die and jig maker, and is now working as a die-sinker on ornamental work.

specimen casting of lead is made in them for ascertaining whether or not they will give the desired result.

The round portion of the impression is sunk first. Swinging the die blank in a lathe, when there is much stock to remove, is a convenient method. In J. H. Williams & Co.'s drop forge shop a cast-iron bolster, for the lathe faceplate, is used. This bolster has a web on its back, which fits the slot in the faceplate. The face of the bolster has a dovetail slot, which is identical with those in the hammer, and is at right angles to the web on the back. By this means a circle is quickly trued up. When the round portion is under $1\frac{1}{2}$ inches in diameter, a profiling machine is better adapted for the work, using the half-round cutter shown in Fig. 2 to finish with, after roughing the stock out with a two-lipped cutter similar to Fig. 3. The half-round cutter is very useful, being strong, easily made, and is easily ground by hand. The one illustrated in Fig. 2 leaves a point in the center of the impression, for spotting the center of the boss on the forging. A die for forging a ball is sunk with a two-lipped spherical cutter. If there is to be a large hole drilled in the forging a plug is left, when sinking, or is afterward inserted in the die to lighten the forging at that point, as is shown at *a*, Fig. 4. This plug should have a taper of 15 degrees on each side, and the top well rounded. In making the dies for forging the piece illustrated in Fig. 4, the round portion, *B*, can be machined out after the part, *D*, is sunk. This may be done with a spherical cutter. In one shop in which I worked a patented attachment for the die-sinker is used, by means of which a cutter can be sunk to its center in the work. The cutter is held in the fixture on a short arbor between half-round centers, around which the cutter is rotated by means of a rawhide gear. The teeth of gear engage the back of the teeth of the cutter. This is only used for finishing. Parts *c c*, in Fig. 4, could be done with this device. It saves time, makes an accurate, clean job and does work that would have to be typed out, *i. e.*, sunk by hand. Some circular impressions are sunk in the milling machine, using one long half-center, and a forming cutter with a small shank, a groove being first cut to clear the shank. The parts *c c*, Fig. 4, would have to be typed in most shops. A type is a hardened steel template, of the size and form that the impression is to be, with the top left soft to prevent the steel from flying when struck with a hammer. Portions of the die that cannot be machined, owing to their irregular shape, or the lack of shop facilities, must be sunk by hand. This requires especial skill with the hammer and chisel, scrapers and gravers, as well as a good eye for judging form. The chisels must be ground to the proper angle on the cutting edge, for chipping the curved surfaces and awkward corners. Scrapers may be made of various shapes, to suit the requirements of the work. One of the most useful is the three-cornered scraper, with two edges rounded; the third, being the cutting edge, is left sharp and is curved toward the point. Another handy one is shown in Fig. 5. It is leaf, or heart-shaped, and is convenient for getting at small curves and corners, especially those at the bottom of the impression. The type is covered with a thin coating of Prussian blue or red lead, and driven into the die from time to time, as the work progresses, and the high places worked down until the correct form is produced. For the fillets and small corners, a graver or scraper is made from Stubb's steel drill rod, of the desired radius. To save room in the tool-box, a 3-16 or ¼-inch rod may be threaded on one end, and these scrapers fitted to it. A hole is drilled in the cutting end to save time in grinding. The scrapers leave small ridges in the work, which are filed out with riffles, or bent files. Some impressions are polished with a soft pine block and powdered emery, but this is not the usual practice. When the impressions are worked out to the lines a lead casting is taken to see where they need matching or evening up. The lead is tested for size, and if all right, a half-lead is taken from the top die, to be used as a template in laying out the trimming dies, that is, in shops where sheet metal templates are not used. If the lead is overheated, or is heated too often, it will not flow freely and chills before the impression is filled. Powdering the impression with chalk causes the lead to flow freer.



Making Drop Forging Dies.

The edger, or breaking down form, on the right of the die, is made from 1-16 to 3-16 inch smaller than the horizontal cross section of the forging, and has no abrupt shoulders or curves. The idea is to get the heated stock smaller in width than the finishing impression, so that the bottom of the impression strikes the stock first, and spreads it to the sides, filling the die. Cast-iron dies are also used for breaking down heavy work.

The flash, which is a recess .015 to .025 inch in depth, and about ⅞ inch wide, milled around the outline of each impression, allows the surplus stock to escape from the die. This surplus is afterward trimmed off in the trimming dies. The top die, also, has a groove about 1-16 inch in depth, milled around the impression, ¼ inch from the edge. The gate for clearing the stock tapers gradually toward the front from the impression so as not to weaken the die at that point.

In dies for making small forgings in large quantities there are several impressions sunk, one of which is used for a rougher, and should be about 1-32 inch narrower and deeper than the finishing impression. Some dies have to be interlocked when difficult shapes are to be forged, that is, the faces have to be shaped to suit the offset in the forging. Care must be taken to have the interlocking parts high enough so that the dies will not glance off when striking the stock, and making an imperfect forging. When the face of the dies is curved special cutters are made, similar to those in Fig. 6, for surfacing and flashing. As a guide for machining curved impressions, some mechanics transfer the lines to the side of the die blank and lay out the curve there, then clamp a surface gage to the profiling machine, and with the needle set to the face of the cutter, work out the stock by following the lines with the needle point. Dies for forging gears, or similar work, are finished with a broach having the teeth machined in it, which is then driven into the die.

Drop forge die-sinking, on the average, pays better than toolmaking or machinist's work. It requires, I think, more manual skill and, often also, more "jackass" power, but not such a general mechanical knowledge as is necessary in tool making. If one becomes expert in sinking dies for drop forgings, and has a taste for the artistic, he can easily work himself into ornamental die-sinking and steel engraving. To follow this up, and become expert at it, requires time and patience, but it holds out the prospect of better wages and better conditions than ordinary tool work.

* * *

A dispatch from Boston says that two fifteen-year-old boys of that city have established a wireless telegraph connection between their homes half a mile apart. This recalls the fact that thirty days after the appearance of the first published accounts of Bell's invention of the telephone, two New York boys had built and were successfully operating an experimental telephone system of their own. These two boys have since achieved distinction in the electrical field, and have for many years been allied in business. They are Prof. Frank B. Crocker, of Columbia University, and Dr. Schuyler Skaats Wheeler.

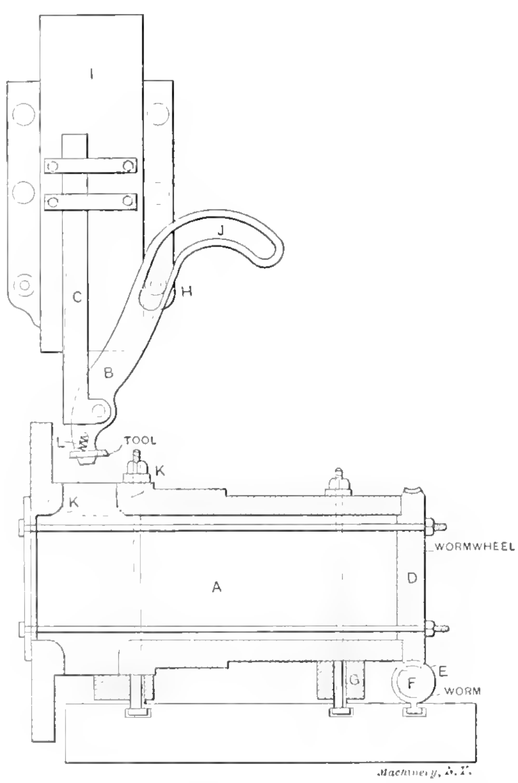
LETTERS UPON PRACTICAL SUBJECTS.

RADIAL SLOTTING ATTACHMENT.

Editor MACHINERY:

I send you a sketch of a radial attachment for a slotting machine that I made for cutting the arcs marked *K* in the breech bushings of the 15-inch coast defence "dynamite" guns made by the Dickson Mfg. Co., Scranton, Pa., for the government. The first bushings were made of bronze and in these the arcs were cast in, but after trying the guns it was found the metal in the bushings would not stand the test, and they were replaced by the best gun steel. In these the openings were cored straight through, as shown by dotted lines. When the bushes were turned and faced it was found the parts *K* could not be chipped or cut to the required radius by any means at hand in the shop. I then devised the attachment here shown.

A is the bushing, *K* is the part to be cut to a radius of about 2 inches, the openings being about 5 inches by 2½ inches wide. Both ends of the slots had to be cut as shown, and there were about ten slots in the circle. *G* shows wooden blocks made to fit the outside diameter, with a piece of sheet iron tacked on the inside so the bushing would turn freely when screwed down with the clamps. *D* is a wormwheel made fast to the back end of the bushings, and a bracket marked *F* is screwed on the table to hold the worm in place. The worm *E* was turned by means of a hand wheel, not shown, to give the circular motion



Radial Slotting Attachment, Working on Dynamite Gun Bushings.

while the cut was fed in by the screw in the table. The bar *C* was forged from machine steel about 2 inches square and was milled out at the bottom to fit the radial bar *B*; it was also cut out as shown by the dotted lines above, so the bar would fold into it when at the bottom of the stroke. The slot *J* is formed so as to give the proper radius to the cutting tool when rounding *K*. The bar *B* was made about ⅞ inch thick by 3 inches wide and the cutter was ⅝ inch by 7-16 inch with a 5-16 inch pivot pin. The slot in the bar was made so that the tool could relieve itself coming back by compressing spring *L*, which forced it again into position. *H* is a stud with a roller, nut and washer put in place of one of the bolts in the head of the machine; when the holes on one side were finished, all that had to be done was to change the stud to the other side, turn the attachment over and proceed as before.

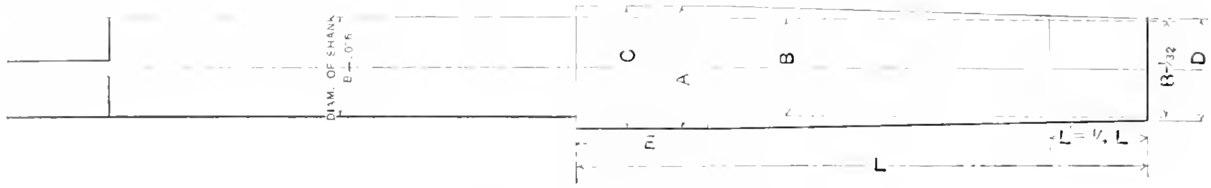


Diagram of Acme Tap illustrating Factors used in Table.

I think that the description and sketch will make the scheme plain and simple to every mechanic, but would add that, of course, a right and left tool was used to cut out the corners.

Plainfield, N. J. D. LINDSAY.

ACME TAPS IN SETS.

Editor MACHINERY:

The table given herewith, on Acme taps in sets, is one which I think will be very much appreciated by many of your subscribers. The formulas, I believe, are correct both as regards theory and practice. I have tried several sets of Acme taps made as per these instructions, and they have given me more satisfaction than any other set of Acme thread taps I have ever tried.

No. of Taps in Set.	Tap.	*C*	*D*	*E*
2	1st	$B + (A - B)\ .65$	$B + .01$	.125 *L*
	2d	A	*C* on 1st tap − .003	.25 *L*
3	1st	$B + (A - B)\ .45$	$B + .01$	.125 *L*
	2d	$B + (A - B)\ .8$	*C* on 1st tap − .003	.17 *L*
	3d	A	*C* on 2d tap − .003	.25 *L*
4	1st	$B + (A - B).4$	$B + .01$	.125 *L*
	2d	$B + (A - B)\ .7$	*C* on 1st tap − .003	.17 *L*
	3d	$B + (A - B)\ .9$	*C* on 2d tap − .003	.20 *L*
	4th	A	*C* on 3d tap − .003	.25 *L*
5	1st	$B + (A - B)\ .37$	$B + .01$	.125 *L*
	2d	$B + (A - B)\ .63$	*C* on 1st tap − .003	.125 *L*
	3d	$B + (A - B)\ .82$	*C* on 2d tap − .003	.17 *L*
	4th	$B + (A - B)\ 94$	*C* on 3d tap − .003	.20 *L*
	5th	A	*C* on 4th tap − .003	.25 *L*

Table giving Proportions of Acme Taps in Sets.

Referring to the cut, the length *L* is indeterminate, as it is governed by four factors, which vary according to the work, viz.: diameter of tap, pitch, length of nut to be threaded, and the material to be tapped. But whatever length of *L* is chosen, if made according to the formulas given, every tap in the set will have the same proportion of work to do as the others; the user will have a well divided set of taps no matter how long or how short the length is made.

A = actual diameter = nominal diameter + 0.02 inch.

$$B = \text{root diameter} = \text{nominal diameter} - \left(\frac{1}{\text{no. of threads}} + 0.02 \text{ inch}\right).$$

The values of *C*, *D*, and *E* are given in the table. The length of *L'* is ¼ *L*, and this refers to the first tap only. The end of the first tap is reduced in diameter, as indicated by the dotted lines, so that it will catch the thread without reaming, which

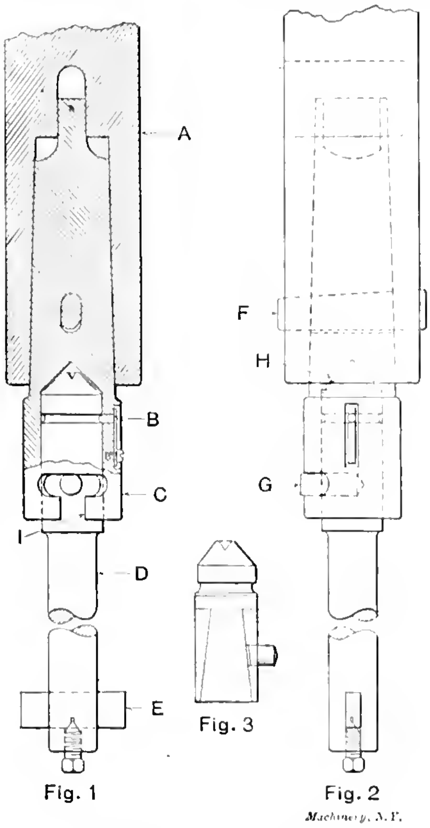
is always the trouble otherwise. With the other taps of the set, of course, this is unnecessary, as the first tap makes the thread deep enough for the following or second thread to catch the lead. In other words, the first tap of the set is made taper in the grooves at the root of the thread for a length of about ¼ *L* to prevent reaming and make it catch the lead easier than would otherwise be the case. A. L. VALENTINE.

Hartford, Conn.

FACING BAR HOLDER.

Editor MACHINERY:

The facing bar holder shown herewith is one of my own design and I believe is new. I find it very good for certain work. The work that I designed the tool for is back-facing boring mill housings, which have to be drilled bottom side up. Its advantage over the ordinary bar with retaining key slot is that the straight bar, *D*, is much cheaper to make, and much easier to change. On a job which requires a variety of bars to face different size holes, considerable time is saved in not having to knock out the retaining key, *F*. Instead bar *D* is disconnected by turning it backward a short distance and



Facing Bar Holder for Drill Press.

slipping it endwise. Again it has the advantage that in case the bar is broken and another one has to be made, the drill press does not have to stand idle while the toolmaker is fitting a new bar in the socket and to the key *F*. The reason for the bar *D* being pointed at the upper end at *H* is to lessen the cost of making; an ordinary drill can be used to drill the socket, and the recess does not have to be squared out in the bottom with the taper end on the bar. The spring and plunger *B* is merely to hold the bar up in place in case the driver pin *G* should become turned backward, so as to be over the center of slot *I*, as sometimes happens when the drill press spindle is reversed.

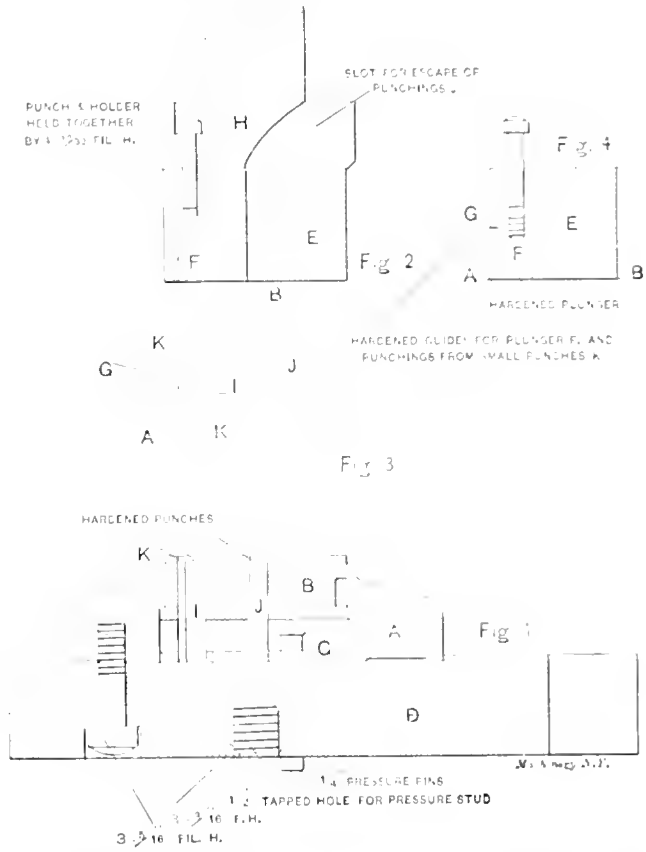
The device is made still more effective for drilling and back-facing holes, say 1½ to 2 inches in diameter, by using straight shank drills with the shanks finished in the same manner as the boring-bar holder. These drills can be exchanged with the boring bars without removing the taper collet. Or in case that is not desirable, collets like that shown in Fig. 3 may be made and used with the drill, the drill and collet being disengaged together. All parts are made of machine steel except the driver pin, *G*, which is made of drill rod hardened and temper drawn to a pale blue. B. M. WELLER.

Franklin, Pa.

PUNCHING DIE FOR MAKING LABELS.

Editor MACHINERY:

Being obliged to get up a set of tools for the cheap manufacture of labels, Fig. 5, I built the following illustrated compound punch and die, one of the requirements having been the use of a single-action press and the production of the piece, Fig. 5, in one operation. As will be seen in Fig. 5 it was necessary to cut the blank, pierce three holes and split the stock between two of the smaller holes on a 5-32-inch radius



Punching Die for Making Pasteboard Labels in Single-action Press

to allow the enclosed material to be deflected for the insertion of an endless loop. The flap was then bent back into place and secured by a small gummed label pasted over the juncture.

Fig. 1 shows the die, the first part to finish being the cutting ring, *A*. The corrugated cutting edge was made by dividing the circumference into an equal number of parts and drilling every other one, the remaining stock being filed up, with

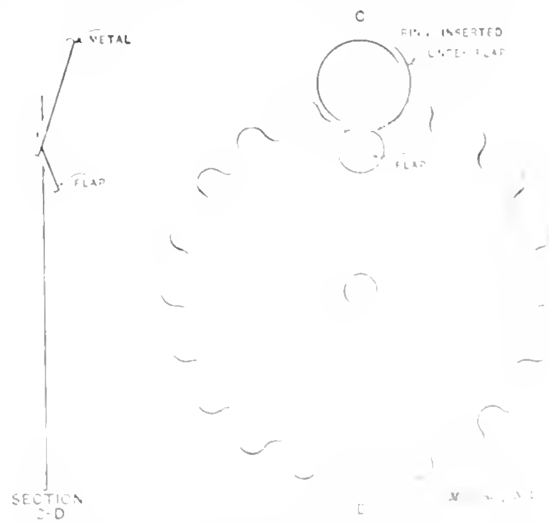


Fig. 5. Label showing Method of Attaching Ring under Flap

hardly any clearance, to an arc of a circle having the same diameter as the drilled holes, thus producing the outline as seen in Fig. 3. The cutting ring was then hardened and ground on the base (which was slightly recessed) and up a short distance on the outer circumference where it fits the

cast iron die plate, *D*, Fig. 1. It was also ground on the cutting edge, which was beveled about 15 degrees.

The main punch, *E*, Fig. 2, was now worked up and finished by shearing it through the cutting ring, *A*.

Pressure plate, *B*, Fig. 1, was turned up with a 5/8-inch annular groove 1/8 inch from the lower edge and deep enough to clear the inside points of cutting ring, *A*. It was then inserted from below into *A*, and cutting edge scribed off and worked up.

Punch holder, *C*, a 1/2-inch steel disk, was next clamped to the plate, *B*. The two largest holes were drilled and reamed through both and then it was used for a drilling jig on the punch, E, after which the largest hole was plugged with same quality of steel, to prevent drill running, and holes drilled for the two smallest punches, *K*. The pressure plate, *B*, was now used to drill the small holes in the punch, *E*, which had also been plugged the same as plate, *B*. The short plug used in the pressure plate, *B*, was used as the plunger, *F*, Figs. 2 and 4, and the plug used in the punch, *E*, Fig. 2 is the long punch, *I*, in Fig. 1, with the top faced off on an angle to enter the main punch, *E*, which acts as a die, splitting the stock to the small holes previously punched by punches, *K*. Plunger, *F*, is faced off to the same angle as punch, *I*, but not quite up to the edge of the small holes which form the piercing dies. The punchings are expelled through the side of the punch, *E*, by the agency of beveled guides, *G*, Figs. 3 and 4.

Plunger, *F*, Fig. 4, was kept from turning by two right-angle guides, *G*, set into small holes above the discharge holes in the punch body, *E*, from the inside, the plunger when in place keeping them from working out. The guides, *G*, were beveled to facilitate the expulsion of the small punchings from *K*, Figs. 1 and 3.

The punches, *K K I J*, were riveted over in punch plate, *C*, Fig. 1, the tapped holes of which were spotted by using die-plate, *D*, for a template.

Allowing the punchings from *J* and *K* to work up through the punch is a decided advantage, since there is no need of cleaning out the scrap from the finished punching, as happens when using strippers, which force the stock back into place. This saves considerable time in assembling on this class of work.

What may be new to some readers is the use of compressed air for carrying away the work after punching, in lieu of gravity, as on the inclined presses. It was successfully made use of in producing the above article on the upright press. The air was compressed on the down stroke and allowed to strike the face of the die on the up stroke, thus carrying the article, which was light, aside. PAUL R. WERNER.

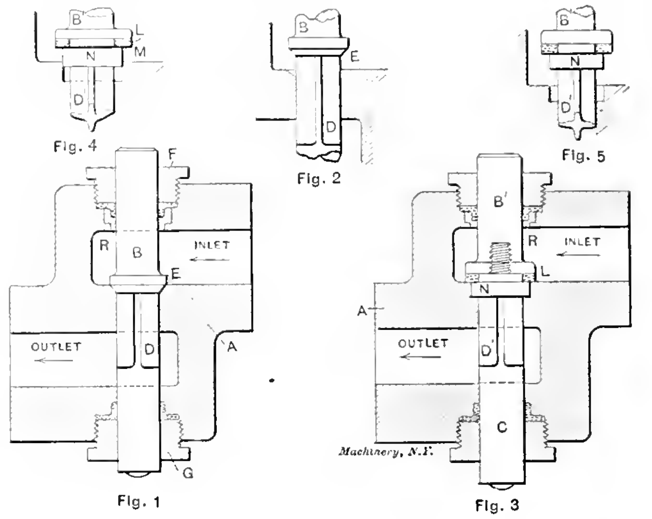
Philadelphia, Pa.

HYDRAULIC VALVE IMPROVEMENT.

Editor MACHINERY:

The illustrations herewith show a hydraulic valve improvement which has proven very satisfactory. The metal-seated valve usually, or rather, I might say, often employed, is shown by Fig. 1. The inlet and outlet are marked, and *A* shows section of the valve body. *F* and *G* are the stuffing-boxes which hold the leather packing rings in place. *B* is the stem cut away to leave only cross ribs at *D*, thus providing water passages when *B* is raised off of the seat *E*, as shown in Fig. 2. As shown, the valve seat is made solid with the body of the valve, but in actual practice this would be separate in order to cheapen repairs. Valves of this style are used in our present installation with water under a pressure of 1,500 pounds to the square inch, and in spite of extreme care taken to keep grit and dirt from the water by filters, etc., we experience more or less trouble continually from the cutting of the seats. The velocity of the water, of course, is at times very high when the valve is open a small amount. Dirt and rust on the pipes, etc., will then quickly groove and destroy a ground brass seat.

To do away with the necessity of grinding the seat and reduce or rather eliminate the leakage when seats become worn or grooved, the style shown in Fig. 3 was adopted. The only change in the design was directly at the valve seat. A leather ring *L* was inserted, which covers the seat joint when the valve is closed. The seat in the body of the valve was then recessed, and the valve stem made to fit fairly tight, as at *N*. Fig 4 shows the valve stem slightly raised and illustrates the use of the part *N*, which as shown, tends to practically keep the valve closed until the leather ring *L* is far enough removed from the edge of valve seat of body to be clear of the cutting action of any dirt carried by the water. As the part *N* does not exactly fit the valve body, a certain leakage will take place as soon as the leather ring is lifted at all, but this amount is so



Hydraulic Valve Improvement.

slight that there is no serious wear on the leather, and its life is, under average conditions, equal to the regular valve seat shown in Fig. 1, and, in addition, has a further advantage of being easily and cheaply replaced.

R is a loose ring which can be removed to allow the larger part of stem *B* to pass. W. T. SEARS.

Harrisburg, Pa.

ACCURATE JIG MAKING.

Editor MACHINERY:

There seems to be a misunderstanding between Messrs. Shailor and Gordon regarding accurate jig making and if you will allow me the space I will express my views on the subject.

In the first place, I infer from Mr. Shailor's article that his description was intended solely for very accurate jig making. On the other hand it appears to me that Mr. Gordon's method of jig making was intended for jigs such as are used in the average shop. If such is the case it simmers down to a simple misunderstanding between above named gentlemen. But if Mr. Gordon really places the drill-press plan on a par with the button method as described by Mr. Shailor, I have a few words to say regarding the method. The subject is an interesting one; in this case the argument should be carried to the end, for the benefit of the younger readers who accept a statement as truth because it appears in a mechanical magazine.

I have knocked around the country quite a little and have made jigs for producing the recognized standard watches of the country but was compelled to use a more accurate machine than a drill-press. Mr. Shailor enumerated ten chances of error that are presented when employing the drill-press plan, but any toolmaker accustomed to fine work can enumerate ten more chances. Therefore a toolmaker using Mr. Gordon's method stands but one chance in twenty of producing an *accurate* jig. I have in mind a watch factory where the limit on the finished product of a jig is 0.0001; it is obvious that the jig must be almost absolutely correct. For an illustration let us suppose that a jig is assigned to a toolmaker, said jig to produce the plates of a stop-watch. For the benefit of the readers not acquainted with the movements of a stop-watch I will say that there are three wheels in each watch about 0.3 inch diameter that operate the split-second hand. The teeth on said wheels are so fine that they can barely be observed with the naked eye. Let the reader imagine that the job was assigned to him and then seriously consider the drill-press plan for producing the jig!

Mr. Gordon admits the chances for errors are in evidence and proceeds to explain how they can be overcome, but we all know the fact remains that the chances are there. The more chances there are for error the more cautiously a workman must proceed and a greater number of obstacles must be overcome before the workman can make one cut on the jig. It needs no argument on this point to convince the reader that the best method is the one that has the least number of chances for inaccuracy to creep in. Mr. Gordon has the assurance that the drill continues straight clear through the work owing to his long practice. He says if it were not possible to drill straight that we would not have gun barrels, etc. For the enlightenment of Mr. Gordon, would say that gun barrels are not drilled straight through the bar. But the hole is drilled through a large bar and the barrel is then turned to size, using the hole for centers. After turning to size the barrel is straightened by skilled workmen with a hammer in the same manner that we would straighten a crooked nail. Mr. Gordon also states that if a drill is started straight and is not crowded and encounters no blow-holes or uneven density of metal it will continue straight. This remarkable statement is equivalent to telling a teacher that if a person had two dollars and spent one there would be one dollar left. The facts are that blow-holes are encountered, the drill is crowded and uneven density does cause the drill to change its path. Mr. Gordon closes with the statement that he can exactly duplicate jigs on the drill-press plan. I claim he can not and am of the opinion that all thinking toolmakers will agree with me.

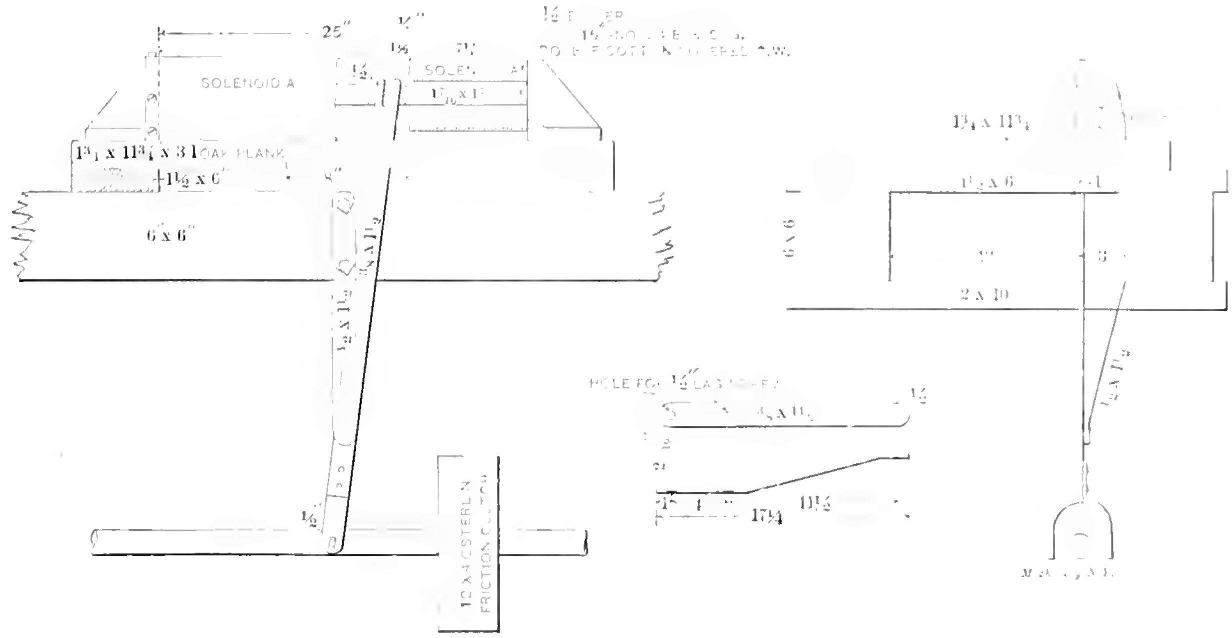
JIG MAKER.

MAGNETIC CLUTCH SHIFTER.

Editor MACHINERY:

The cuts, Figs. 1, 2 and 3, show a magnetic clutch shifting device, and the switch used for operating it. It is used to operate a 4 x 12-inch friction clutch which is belted to the feed of a 36 x 15-inch Gates crushing rolls used for crushing rock. The feed must sometimes be stopped, and it was inconvenient to have an ordinary clutch shifter about, so solenoids were used to throw the clutch instead. The solenoids are operated by a 250-volt lighting circuit and are controlled by the double-throw gravity switch shown in Fig. 3. To start the feed the ball lever is moved to the left to the position marked "feed on" and held there about a minute, and then allowed to fall to its vertical position. To shut off the feed the ball is moved to the right to the position "feed off," and then allowed to fall back to its normal position. One terminal of each solenoid is connected to the same feed wire and the other terminals are connected to the double-throw switch at C' and C''. The middle terminal C connects to the other feed wire. Hence when the ball handle is thrown in one direction solenoid A, for instance, is operated, and in the other solenoid A'. In the middle position no current flows through either solenoid. A number of these double-throw switches are located near the rolls or near other points where trouble may require the stoppage of the feed. The device has been in use for some time and works very satisfactorily.

Desloge, Mo. HERBERT S. GLADFELTER.



Figs. 1 and 2. Magnetic Clutch Shifter.

HERBERT S. GLADFELTER was born in St. Louis, Mo., April 7, 1882. He has worked for the Curtis & Co. Manufacturing Co., the American Arithmometer Co., the Laclede Gas Company, the St. Louis Smelting & Refining Co., and others. He is a draftsman and machine designer.

COMPOUND PUNCH AND DIE FOR STEEL RANGE WORK.

Editor MACHINERY:

I show herewith a punch and die which I designed recently for punching rivet holes in the strips which make the top of a steel range stove. I am of the opinion that this die is con-

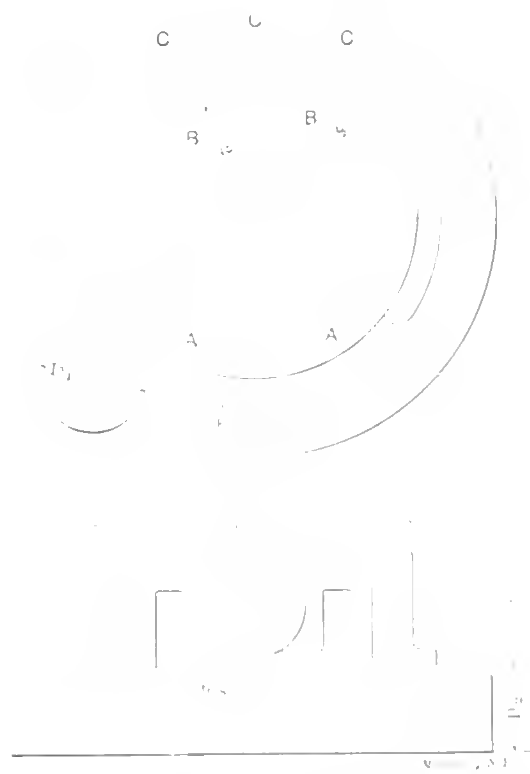


Fig. 3. Switch for Operating Magnetic Clutch Shifter.

structed and built on different principles than any I have seen in the columns of MACHINERY. If one is looking for cheap production and modern methods, I think this tool will do the

business, for it does in one stroke of the press what would require three separate operations, if done one operation at a time. The die is what I would call a twin die, and punches either right or left as the case may be, and in making the die this way I found that it saves three handlings of the work.

Before I describe the tool I would like to say a few words in regard to this tool and what it will do. Of course, everything is done piecework in the shop, and I am figuring this on a piecework basis. We will say there are 1,000 stoves to be made, which means there are 4,000 strips, for it takes four

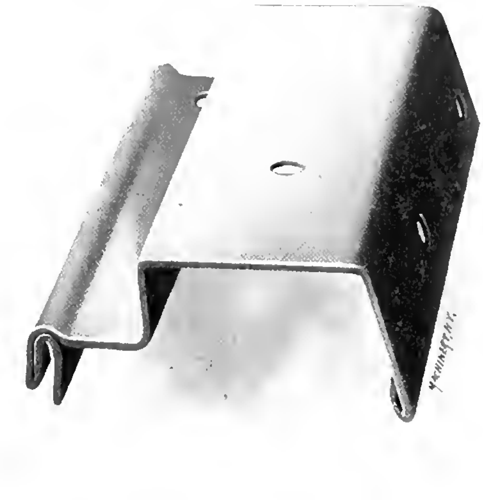


Fig. 1. Sample of Work done on Compound Punch and Die.

strips to each stove, and 20,000 holes to be punched in these strips, and if it were to be done one operation at a time, it would take a man about three days to do the work. This would cost $6.00 and keep the press tied up thirty hours. But the tool I show herewith will do the work in ten hours at a cost of $2.40, and give us twenty hours more use of the press and two days more use of the man for something else. These prices are figured at three cents a hundred holes, and for the tool I show six cents a hundred strips, which makes a difference of

make them more rigid, so there is no chance for them to shift and change the alignment with the punches *J*. The punch holders *D* are made of machinery steel, and are made a nice working fit in the pieces *G*. It will be noticed in the sketch that I have left a small tenon on the pieces *D* for the purpose of giving more stock for the setscrews *P*, which hold the punches *J* from pulling out. The vertical punches *I* are four in number and are held in place by means of the setscrews *O O*.

This die was made for a press having a 1¼-inch throw, and the side punches *D* have ½-inch travel; while the ram of the press is traveling 1¼ inches, the side punches move in ½ inch, being operated by the slotted pieces *A*. The pieces *A* are of machinery steel, and casehardened, and are fastened to the piece *E* with ⅜-inch cap screws *L* and two 5-16 inch dowel pins *N* in each piece. The die block *F* is mortised to guide and support the four pieces *A*, and at the highest point they project about ¼ inch into the die block. In this way they are well supported when taking the thrust of the side punches *D*.

After having determined the location of pins, *H*, the slots, *K*, were laid off, giving a horizontal traverse of ½ inch in the diagonal portion which of course gave me the right amount of travel for the side punches. The pins, *H*, are of tool steel, hardened and drawn to a dark straw color, and held in place, as shown in the sectional sketch. The sizes of the holes punched are No. 1 and No. 6 respectively Brown & Sharpe gage, and the material is No. 16 gage. There is also a stripper fitted to this die, which strips the stock from the punches, and acts as an end gage, not shown. There are also two pieces of rubber placed between the punches *I*, which force the work down on the piece, *C*, holding it firmly so that every one is punched alike.

I have tried to show this die as plainly as possible, in the sketch, and also to make the description clear to the readers. In conclusion I wish to say I, for one, would be pleased to see more dies of this nature described, and I hope this may be the means of bringing forth from the readers of MACHINERY a great many tools constructed along these lines.

Lorain, O. W. VAN ORMAN.

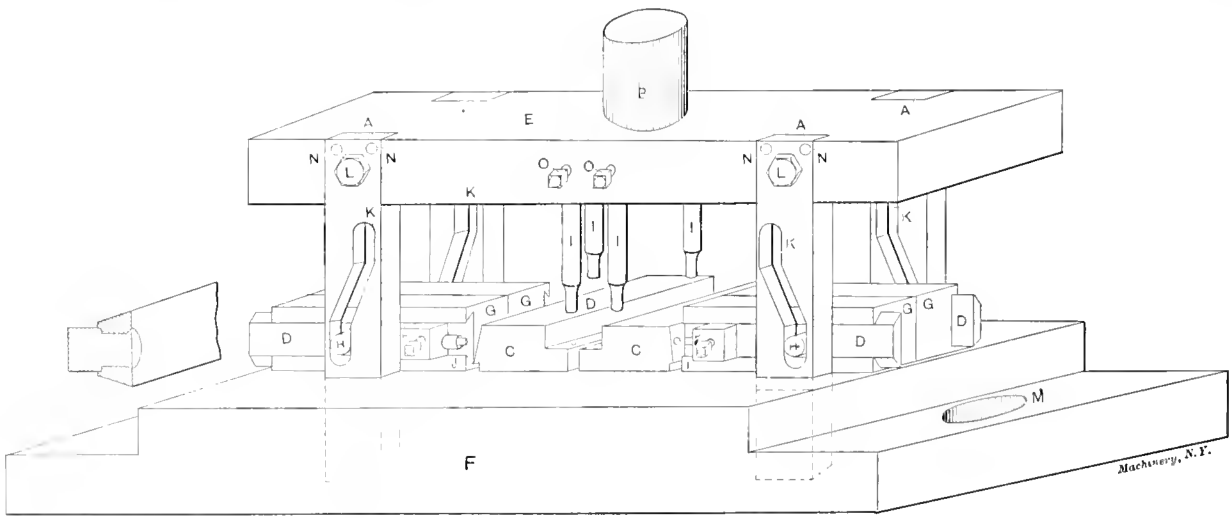


Fig. 2. Compound Punch and Die for Steel Range Work.

$3.60 on a thousand stoves, besides having two days more use of the machine. Since writing the above, 600 strips containing 5 holes each, or 3,000 holes total, have been punched in one and one-fourth hours at a cost of five cents per hundred strips.

The punch holder, or upper half of the die *E* is of cast iron and is mortised out to receive the four pieces *A* which operate the side punches *D*. The shank *B* is of machinery steel and is made a driving fit in *E*. The bolster plate *F* is of cast iron and is fastened to the bed of the press by bolts through the holes *M*. The four pieces *G*, which hold the sliding punches *D*, are of cast iron and are dovetailed; each piece is fastened to the bolster *F* by means of two ⅜ inch fillister screws and two 5-16 inch dowel pins from the under side, which are not shown. The pieces *C* are also of cast iron and are made to conform with the shape of the strip to be punched; they are held in position the same as the pieces *G*, being doweled to

SPRING STRIPPERS CONSTRUCTION.

Editor MACHINERY:

I send you sketches of two spring strippers for use on small punches. Fig. 1 was designed to avoid broken punches caused by the spring in the ordinary form (with spring on the inside of stripper shell), getting in under the punch occasionally, and "putting it out of business."

In Fig. 1 punch *A* is fitted into the punch head and fastened by a setscrew as usual. Bushing *B*, is a shell, the upper end of which is a "drive" fit on punch *A*, and the bottom end is a sliding fit over stripper *C*; it has holes for pin, *E*, about ¼ inch from the lower end as shown. Stripper *C*, is a nice sliding fit over punch *A*, and has a shoulder on lower end to retain the spring, *D*, which is of the ordinary coil type. At the top it has slots through which pin *E* slides, forming a stop and also preventing stripper, *C*, from turning around on

punch, *A*. To set up, remove pin, *E*, stripper, *C*, and spring, *D*. Set up the punch in the die; then when the ram is up place the stripper and spring again in position and fasten with pin, *E*. I have used this construction for two years with satisfactory results.

Fig. 2 is for stripping piercing punches consisting of more than one punch in a single head. I drill four holes (one in each corner) in the punch head as shown, counterboring

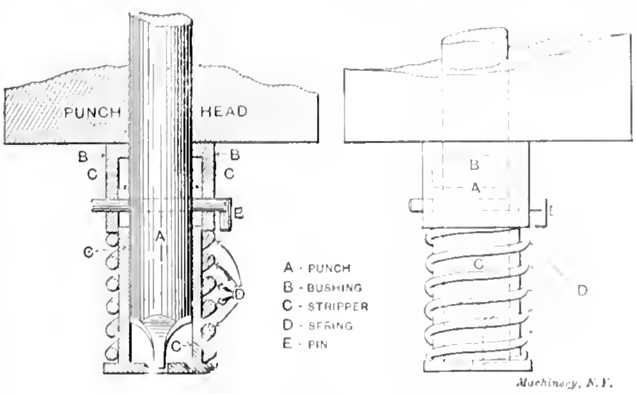


Fig. 1. Sectional and Side Views of Spring Stripper.

nearly through from the top. I insert into each hole a plunger, *A*, and spring, *E*, holding spring, *E*, in position by pin, *D*, and insert a bushing, *B*, in each corner through the holes corresponding to those in the punch head. Now set up punch and die in usual manner, raise ram of machine and place stripper plate, *F*, in position. Plungers, *A*, fit into holes in corresponding bushings, *B*, and are fastened by means of the pins, *C*, as shown. The advantages of this stripper are that it is easily and quickly adjusted, the springs are always

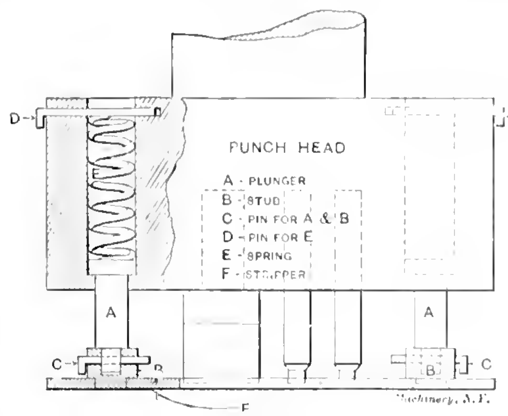


Fig. 2. Stripper for Piercing Punches

in position and out of the way, and the operator does not have to work against the tension of the springs as he does in the usual form. It is substantial, efficient and a time and profanity saver in setting up, as the operator simply takes it off, sets up the punch, and puts it back again. We have used this design for nearly a year, and have discarded the others.

V. H. MARCELLUS.

Belvidere, Ill.

SOME HINTS ON BENDING DIES.

Editor MACHINERY:

The illustrations herewith show two styles of bending dies for curling the hinge shown in Fig. 5. Tools and appliances for the making of hinges are about as numerous and vary in design as much as the hinges themselves; they range from the simple punches and dies for blanking and curling in separate operations, to the complicated automatic machines and press attachments, for producing the hinge, complete, with the two parts and pin assembled. The writer has worked on the machines which perform this last-named operation, or multiple of operations, as well as on several types of dies for the same purpose.

The exact design of a die for making a hinge or any other difficult piece of work cannot be selected arbitrarily, but must be governed by conditions. Of course a style of die should be decided upon whose first cost is not out of proportion to the amount saved by its use. The two dies here shown and described are for curling both parts of the same hinges and are merely two differently designed tools for doing the same job. While the diverse plans are for the same requirements it may be interesting to state that the ratio of production between the two dies was about 5 to 7 in favor of Figs. 3 and 4. This was noted as they were being used at different times in the same press and by the same operator, the press being run at as high a speed as is consistent with good practice. Although these dies are simple in design and construction, there are several points in each where close work is essential to accurate and uniform production, *i. e.*, accuracy of the parts which curve the metal; smooth finish on these parts and care in hardening; to have them as hard as possible, as there is considerable wear at this particular point from the friction of curling. Care must be exercised in the setting up of the dies, to insure perfect alignment with the punch so that when the V on the lower side of the latter engages the upper edge of the blank, it will be held in line with the slot

Fig. 1

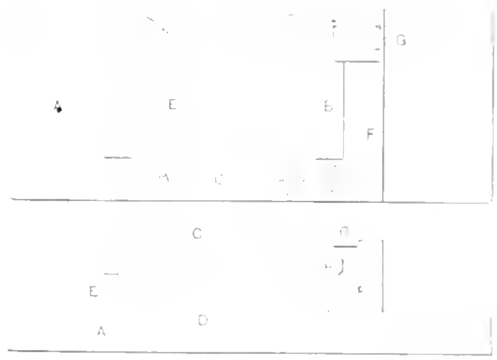


Fig. 2

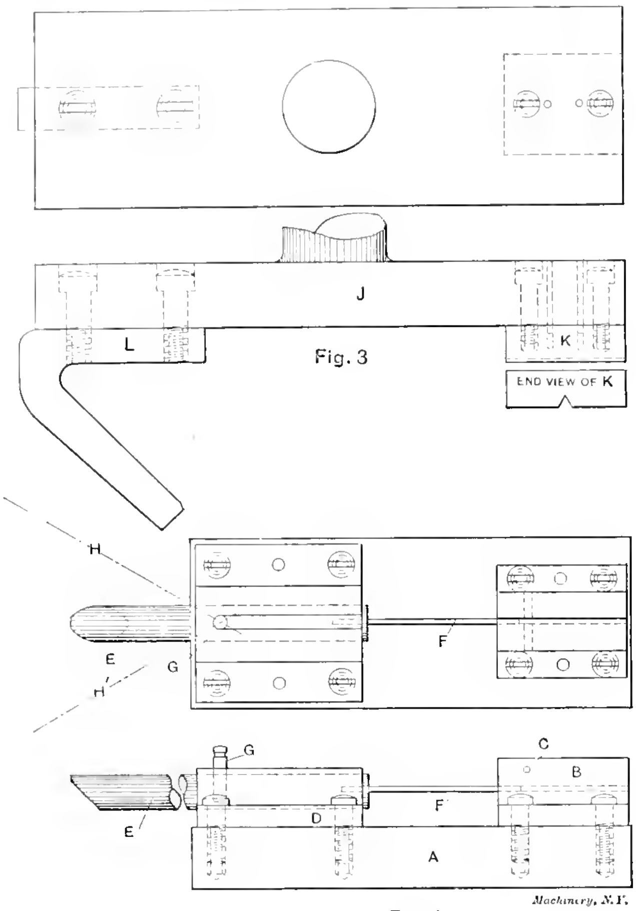
Figs. 1 and 2. Design of Punch and Bending Die for Curling Hinges No. 1

in the die that receives it, otherwise the work will have a tendency to buckle. Moreover, carefully adjust the stroke of the press, to allow it to descend just far enough to complete the curl, and no more. If it comes down too far the work will jam in the die, and difficulty will be experienced in removing it without injury to the die. It is essential that the proper lubricant be used on the blanks according to the metal employed, and also, that every blank be dipped to eliminate unnecessary friction in the curling action. We have observed from the action of hinge dies of this character, for small work, that there is a very narrow margin between the development of a good and a bad curled hinge, and that it takes very little deviation from the ordinary conditions to make the latter.

When dies for turning out the work under consideration are made of the above types and properly constructed, the results will be all that can be desired. They work well and rapidly and turn out the maximum amount of work before requiring repairs or renewal. It is important for the successful running of these dies that there be no pronounced

burrs on the blanks, and especially so in regard to Figs. 3 and 4; prominent burrs would preclude the use of this type altogether, as the opening to receive the work can only be about .003 inch wider than the thickness of the blanks, consequently, the piercing and blanking die must do good work in order to show final results.

The die, Fig. 2, consists of seven parts: The holder or body *A*, of cast-iron; the slide, *B*, of tool steel, hardened and finished



Figs. 3 and 4. Design of Punch and Bending Die for Curling Hinges, No. 2.

by grinding; the cast-iron cap *C*, secured to *A* by four screws, and holding in place the slide *B*, yet permitting it to have a free lateral movement; the spiral spring *D*, which is for the purpose of moving the slide outward on the upward stroke of the press, by the pressure against pin *E*; the tool steel die *F*, which curls the blank, forming the hinge, and *G*, which is the gage to locate the blanks, and prevents the operator from putting them too far back in the die.

The punch, Fig. 1, consists of the holder *H*, finished top and bottom with one end slotted to receive the cam *I*, which is secured by a cap-screw. The working face of this piece is polished and made as hard as fire and salt water will permit, and engages the corresponding angle on the outer end of the slide *C*, in Fig. 2. Secured by two screws to the opposite end of the punch holder, is the punch *J*, having a small V planed in its lower face to engage the upper edge of the work.

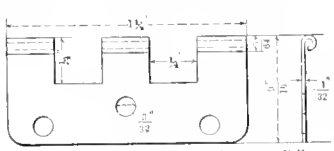


Fig. 5. Sample of Hinge Curled.

When in action the blank is placed in position between the inner end of the slide and the die proper; the punch descending, forces the slide firmly but lightly against the side of the work, and the continued downward movement of the punch performs the operation. On the up stroke the slide is pushed out to its limit by the spring, permitting a free removal of the finished work and the insertion of a fresh blank.

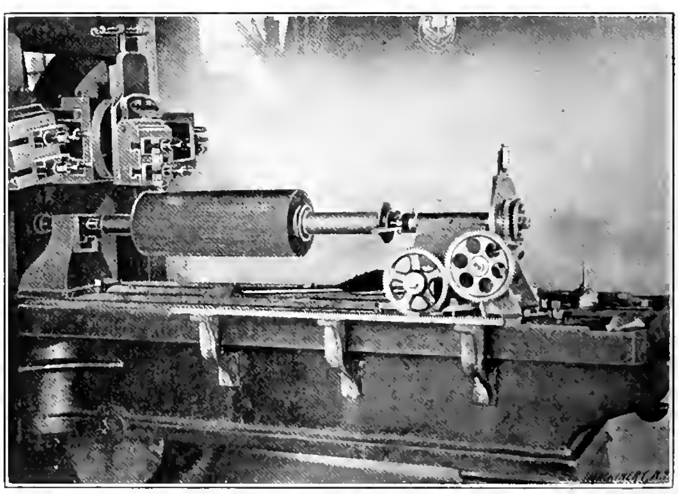
The sketches, Fig. 3 and Fig. 4, illustrate the second die. *A*, Fig. 4, is the cast-iron base, *B* is the die, and *C* is the stop pin. The die is fastened to the base by screws and dowel pins. Mounted in the rear of the die *B*, and fastened to *A* by screw and dowel pins, is the bracket *D*, carrying the sliding shaft *E*. Inserted in the forward end of this shaft is a piece of Stubb's drill rod *F*, the outer end of which is hardened, and fits in the hole in the die. Driven into shaft *E* is a spring post, *G*, to which are hooked two closely coiled springs, their opposite ends being fastened to pins located in the bolster, in such a position as to line the springs at about the angle indicated by the dotted lines *H H'*. On the down stroke of the punch these springs hold the shaft in the position in which it is drawn. The object of the angular arrangement of the springs is two-fold: permitting the cam *L*, Fig. 3, to pass between them, and also, minimizing the possibility of an accident. Should one spring break, the other is sufficient to do the work. The punch, Fig. 3, consists of the holder *J*, steel die *K*, and angle or cam piece, *L*. When in operation the punch descending allows the stripper shaft *E*, Fig. 4, to be withdrawn, by the springs, in time to clear the blank as it is forced down and curled. On the return stroke the shaft is positively advanced, by contact with the angle piece on the punch, ejecting the hinge from the die. This tool had to be, of necessity, operated in a press of the proper stroke to prevent the angle piece *L* raising entirely clear of the end of the shaft *E*. This stripping arrangement permitted a continuous feeding of the blanks to the die, increasing the output over the other punch and die in about the ratio above referred to. C. H. Rowe.

Worcester, Mass.

PLANING SPIRAL CORRUGATED ROLLS.

Editor Machinery:

We recently had some corrugated chilled cast-iron rolls, all belonging to a feed grinding mill, come into the shop to be re-corrugated or sharpened. If the flutes had been straight, this would have been a simple matter, but as they were in the form of a spiral extending around the roll 1-42 of a revolution per foot in length, or 8 4-7 degrees per foot, they presented somewhat more of a problem. Each roll weighed about 400 pounds, and we mounted it on a pair of Fay & Scott's 20-inch planer centers. On the outer end of the head spindle was keyed a disk carrying an index pin. Outside of the disk and loose on the spindle was a worm gear to which was fastened the index plate.



Planing Spiral Corrugated Rolls.

To prevent undue strain on the index pin when the roll was being revolved, binder bolts were passed through the worm gear extending into a circular T-slot in the disk, and it was of course, necessary to loosen them when revolving the roll by hand to the next corrugation. For revolving this work to obtain the spiral, a horizontal shaft extended out to the side of the planer platen on which was mounted a gear. This gear running in a stationary rack fastened to the bed of the planer gave the proper speed to the roll when the platen was in motion. The extra intermediate gear shown was to change the direction of revolution of the roll, as we happened to have a left-hand worm which was used in place of a right-hand, which would have given the right direction without use of the intermediate gear. We found it necessary to slow the planer down

to about one-third speed, and then tried several makes of high speed steels before we found one which would cut this chilled iron in an economical manner. W. L. FAY.

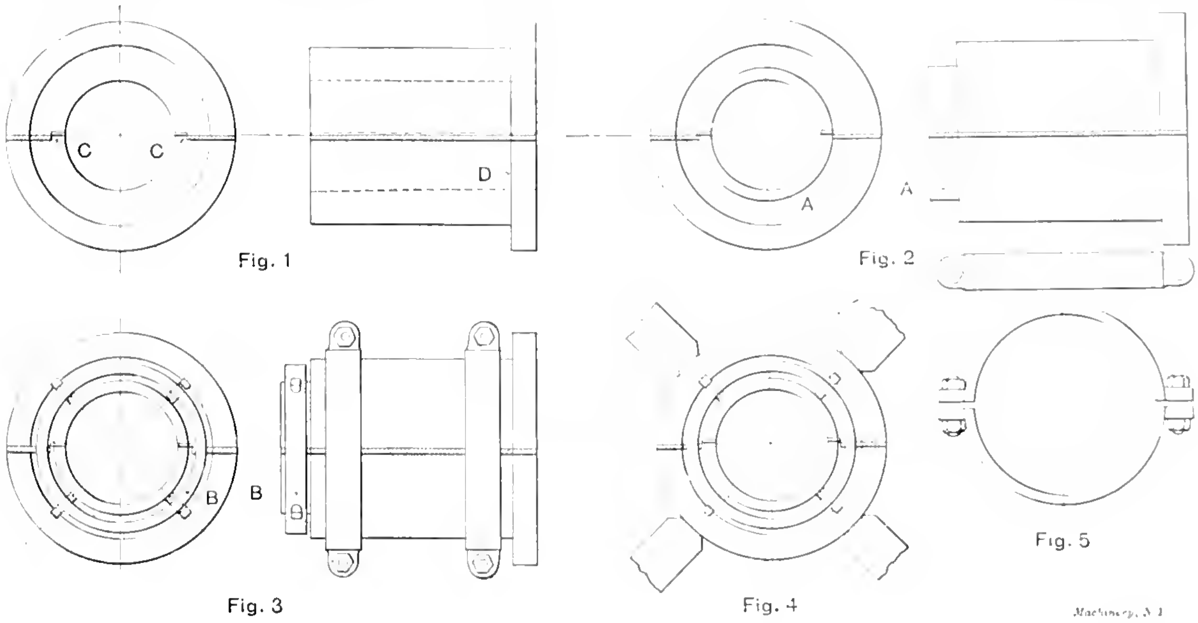
Dexter, Me.

METHOD OF BORING AND TURNING A CAST IRON BUSHING IN HALVES.

Editor MACHINERY:

Some time ago in the shop where I am employed the question came up as to how we could bore and turn the cast iron bushing shown finished in Fig. 1. The bushing is in halves, and is used in the end crank bearings of a two-cylinder vertical gas engine. After some figuring we decided to do the job in the following way:

First, the bushing was cast with the projected ring on the end as shown at *A*, Fig. 2. The halves were then planed in



Method of Boring and Turning Cast Iron Bush in Halves

the usual manner, with the shoulders *C C* in Fig. 1. Next we made a steel ring with setscrews as shown at *B*, Fig. 3. The halves of the bushing were then placed together with the proper size shim between; the steel ring was next placed over the projected ring of the bushing and the setscrews tightened. The work was placed in the lathe chuck and centered as shown in the end view of Fig. 4. It was bored and turned and the edge, *D*, in Fig. 1 faced. While still in this position in the lathe two clamps like the one shown in Fig. 5 were slipped on the bushing and tightened as shown in the side view of Fig. 3. The bushing was then taken out of the chuck and slipped on a mandrel. The flange end was turned and the projected ring turned off, this being the last operation and finishing the job. This method of boring and turning the bushing makes all of the surfaces perfectly true with each other.

Dayton, O. A. J. BRUTSCHE.

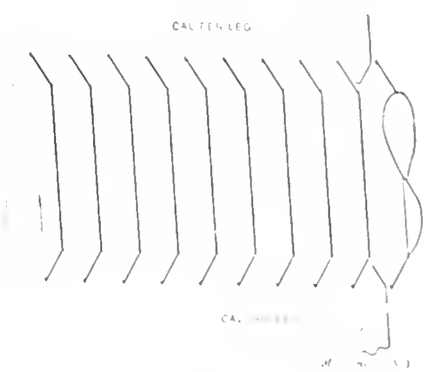
CALIPERING THE FIT OF A SCREW THREAD.

Editor MACHINERY:

The fit of a screw with V-threads is on the incline face of the thread only, and not at either sharp point top or bottom; but I find it to be decidedly common practice among machinists to use a thread caliper which is sharpened to a thin sharp point. This is a mistake, for the reason that in case the thread tool should crumble the least bit or get dull at the extreme point, it leaves a little fillet at the very point at which the caliper is indicating, and then the man is at sea as to the thickness of the thread.

To remedy this evil, I would advise him to take a pair of ordinary outside calipers and file the points to fit a thread tool gage, leaving a slight space flat at the extreme point as indicated by the sketch submitted herewith, thereby avoiding any chance of touching the bottom. Then when the caliper is tried over the work it will be found to fit on the flat incline surface of both sides of the thread, thereby calipering the work just where the bearing surface is. When the thread cutting tool is properly ground the extreme root of the thread will take care of itself. Some men advise making the points of the caliper points slightly round instead of a fit to the thread gage. By using the above described style of caliper points the lathe man is able to vouch for the accuracy of the fit he is making, just as well by the calipers as he can after he has tried the pieces together. I have found the scheme efficient, as will be seen by relating a circumstance which occurred when I was working on the night shift in an engine shop.

When I came in to work in the evening I found standing beside my lathe, nine piston rods to be finished to size (the piston head had been put on and riveted solid). They were $2\frac{1}{4}$ inches diameter by 30 inches long, and were to have a thread cut up on the end $3\frac{1}{2}$ inches long with 8 threads per inch, which had to be a perfect fit to the cast steel crosshead. The entire rod and head weighed about 150 pounds, while the crosshead weighed 110 pounds. They were the high-pressure heads for a 12- and 22- by 12-inch compound engine. I used the sort of thread caliper above described, in fitting the threads, and found each rod to fit perfectly the first time I tried them into the crosshead. At 12 o'clock at night I had the entire lot



Calipering Screw Thread

completed, every one of them stood their test, and passed the inspection O. K. Previous to the time I introduced these thread calipers, it had usually been one hour's job to fit each thread alone, to say nothing of the finishing cut on the blank or straight portion of the rod. H. E. WOOD.

Pearl River, N. Y.

A COMBINED CUTTING, DRAWING AND KNURLING DIE.

Editor MACHINERY:

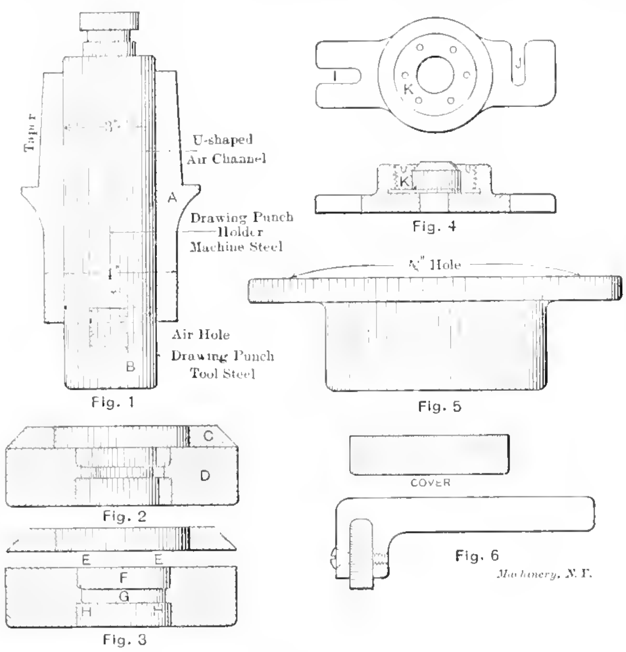
The cut shows a set of cutting and drawing tools used in a double-acting power press for cutting and drawing a so-called knurled cover, in one operation; also a die bed or bolster which is quite a time-saver, and is used in connection with

this set of tools. These tools cut and draw a brass cover 3 inches diameter and ½ inch long—thickness of metal 0.050 inch—which is used on a cylinder-shaped metal box, the outside of the cover being ribbed or milled for convenience in screwing on or off the box.

Fig. 1 shows the cutting punch, *A*, which is 4 inches diameter at the cutting part. It has a taper shank and is made a driving fit in the punch holder, Fig. 5, which is held in the press by two ⅝-inch screws.

The drawing punch, *B*, is made in two parts. The drawing part is made of tool steel and is 3¼ inches long and has a 1-inch tapped hole in the end where it screws on the punch-holder. The punch is hardened and ground, and is lapped smooth to size. The air hole shown not only makes it easier to draw up the shell or cover, but it enables the cover to be more easily stripped from the punch. The drawing punch holder is used for different sizes of drawing punches, and is held in the press by a yoke key, or as some diemakers call it, a U-shaped key, which fits the nipple on the upper end of the holder.

The die is made in two parts, namely, the cutting part and the drawing part. The cutting part is made of tool steel, and is hardened and ground on the top and bottom; it is beveled



Combined Cutting, Drawing and Knurling Die.

on the side to correspond with the bevel on the threaded collar shown in Fig. 4 at *K*. The 4-inch hole is ground and has very little clearance, for the reason that if too much clearance is given it will cause the blank to shift from side to side after it is cut, thereby causing the cover to be uneven in its length.

The drawing part is made as shown in Fig. 3. *F* and *G* are the parts that draw up the ribbed cover after the blank is cut. The mouth of die is rounded, as shown at *EE*, thereby making it easier to force the blank through the die. The diameter of *F* is made 0.020 inch larger than *G*, and it draws up the cover before it is ribbed by *G*. The diameter of *G* is made a trifle smaller than the required size, as the cover expands slightly after having passed through the die. The corners, *HH*, are made sharp and strip the cover from the drawing punch on the upward stroke of the press. Part *G* is ribbed or milled with the knurl shown in Fig. 6.

Fig. 4 shows the bolster for holding the die. The die is held in position by the threaded collar, *K*, which is screwed down upon it by the aid of a spanner wrench having two pins which engage in the holes shown. This bolster differs from the one most generally used inasmuch as it has the slots for the screws running at right angles with each other. When taking the bolster out of, or placing it in the press, the screws need never be any more than just loosened up, while with the other style, one screw must be taken out entirely before the bolster can be removed. When placing this bolster in the press, the slot, *I*, is engaged with the screw on the left, after which the bed is swung to the right until the slot, *J*, engages the screw.

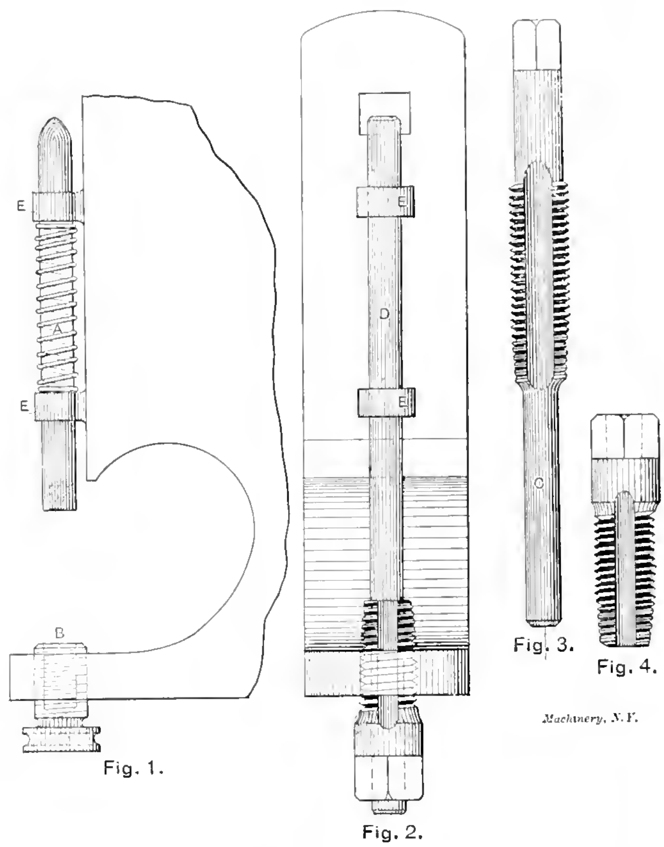
The arrangement used for guiding of the metal, and the stripping it from the cutting punch is not shown, but is similar to those that have been described in MACHINERY from time to time and therefore needs no explanation. The covers are threaded after they leave the press; they are then cleaned and nickeled and are then ready for use.

C. F. EMERSON.

A TAPPING EXPERIENCE.

Editor MACHINERY:

In the accompanying sketch, Fig. 1 illustrates a portion of a machine for setting metal parts in a fabric. *A* is the ram, or plunger, and *B*, is the bolster. Both of these parts carry a die. In tapping the base for the bolster, *B*, we used the tap, Fig. 3, with a pilot pin, *C*, running up through the lug, *E*. It seems as though this should bring the plunger in line with the hole in the base, but it was found on examination



Showing use of Hollow Tap.

that it did not, some varying as much as 1-32 inch, which wrought havoc with the metal parts being set. So the foreman designed the hollow tap, Fig. 4. This tap was bored a snug fit for the bar, *D*, which passed through the lugs, *E*, *E*, and the hole to be tapped, the hollow tap was slipped over it and the hole was tapped. In this manner the tapped hole came in exact alignment with the plunger.

PEDRO RE.

* * *

An error occurred in Mr. L. S. Burbank's article "Table of Spur Gear Teeth Giving Diametral Pitch," in the December, 1904, issue. In the explanation of the table the statement: "As the products of , s and $\sqrt{\frac{2.51}{W}}$ (the loads and velocities) divided by 33,000 give the horse powers, etc.," obviously should have read: "As the products of the loads and velocities divided by 33,000 give the horse powers, etc."

* * *

A little kink in the lacing of belts is mentioned by the *Mining Reporter* which makes it easier to thread the ends of the lacing leather through the belt. The ends of the laces should be gently charred over a small flame, a lighted match, for instance, using care that the leather is not burned, and it will be found that the ends have taken a stiffness or rigidity sufficient to enable them to be readily pushed through the holes in the belt.

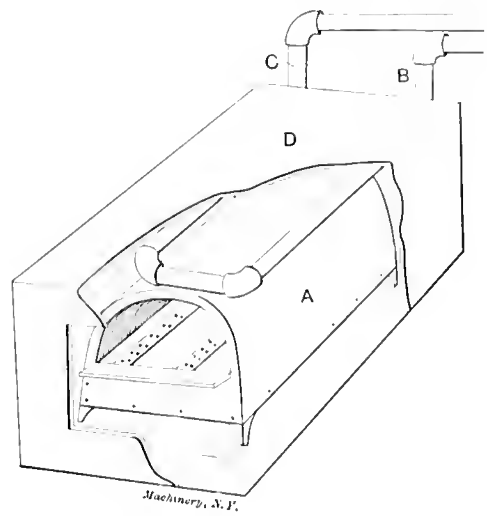
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

HOT WATER FOR THE TIN SHOP.

Shops using soldering furnaces and not run by steam power, may have hot water in abundance by using this design. It is in practical use and furnishes us with abundance of water, scalding hot. An old style kitchen range outfit is used, that is, a regular galvanized boiler, and a coil of pipe. Referring to the sketch, *A* is the soldering furnace; *B* and *C*, the pipes to and from boiler; and *D*, a sheet iron (1-16 inch

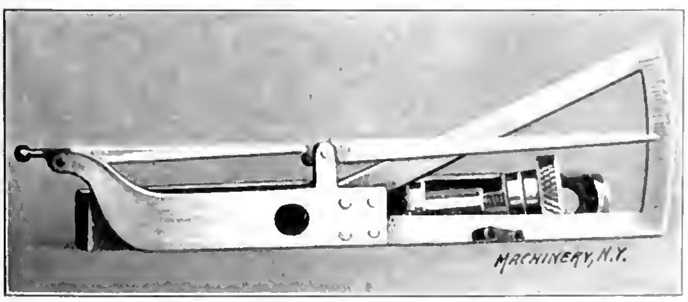


or ⅛ inch thick) covering, lined with thick asbestos paper or fire clay. The furnace is set about 4 inches back of the front of the covering. The bend of the pipes is over the front edge of the furnace, so as to catch the bare flame, escaping from the front end of furnace. All pipes used are 1 inch, except the pipe running from the boiler to hydrant, and this is made ½ inch. PARK B. SHILE.

Lancaster, Pa.

A SIMPLE INDICATOR.

The half-tone shows an indicator, for testing the truth of work, that I find to be very sensitive and reliable. It is so simple in construction that an apprentice can easily make one for his own use. It consists of a frame supporting two levers arranged in tandem and swinging upon hard steel pivots, a reading scale, a ball, a bolt with thumb-nut, and a holder for use on the lathe. With the bolt the indicator may be screwed to a surface gage, and the frame is of such a shape that it may be easily clamped against any flat surface. Since gravity, and not springs, is relied on to work the lever, the tool must



always be used in or near the horizontal position, but with some special attachments it may be used as a universal indicator, and I use none other in the shop. The ball shown in place is used in truing up work by a hole, a button, a prick punch mark, etc. When truing work by the prick punch mark we use a "wiggler," which is made in two parts, one telescoping the other and provided with a spring for holding them apart. This is preferable to a solid wiggler, because it can compress as the prick punch mark nears the center. The small attachment shown in the illustration is used instead of the ball to test lathe centers, faceplates, large shafting, and all work of a similar nature. The first or short lever is 2.1 inches long over all, the distance from the center of the ball to the pivot being 0.25 inch, and from the pivot to point of contact with second lever 1.75 inch. The long lever is 2.65 inches long over all, the distance from the contact with the first lever to the pivot being 0.11 inch, and from the pivot to pointer end 2.47 inches. The distance between the pivots is 1.86 inches, and the total length of the tool is 4.77 inches. The short graduations on the scale represent 0.0002 inch, and the long ones 0.001 inch. The graduations were marked off from actual measurement on the ball point of the first lever.

Great Barrington, Mass. J. MATHIEU.

PIPE CENTERS—KEYSEATING BAR FOR SHAPER USE.

Figs. 1 and 2 show male and female loose head pipe centers for lathe use. The head *A* may be made of either machinery steel or cast iron. The hole is bored taper, and the stem *B* is fitted, and driven in tight enough to allow it to be used as an arbor for turning the head, thus making it true. When finished, two or more steel buttons are made to fill

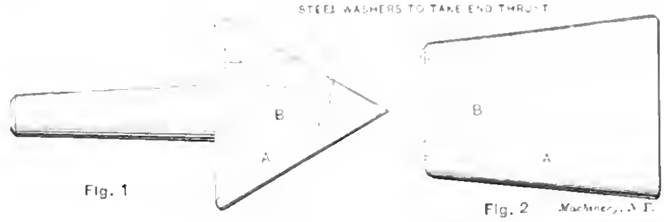


Fig. 1 Fig. 2

the end of the small hole and act as a step bearing to take the end-thrust when the center is in use. Enough buttons should be used to hold the head in position on the stem so there will be no lost motion and still have it turn freely. The pipe center is a tool which is almost indispensable, where all kinds of work are done, to hold pieces being bolted to the face plate, to hold and turn any piece with a hole in it, and many other jobs.

A handy bar for use in a shaper for key-seating may be made like Fig. 3. The tool-post of the shaper having been re-

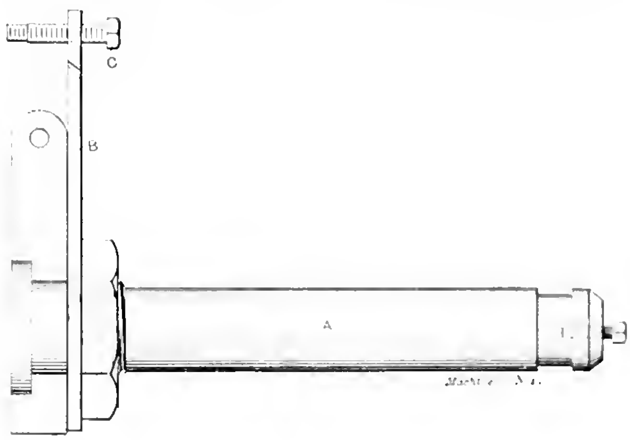


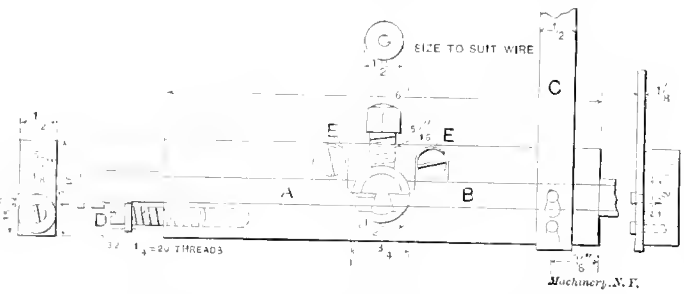
Fig. 3

moved, the key-seating bar *A* is placed in the clapper block and a piece of spring steel *B* about 3-16 to ¼ inch thick and from 2½ inches to 3 inches wide is bolted under the nut. The steel spring has a hole a little larger than the diameter of the thread on the bar, and extends high enough to reach a good resting place for the tension screw *C* at the upper end. The outer end of the bar has a hole about ½ inch square for the tool, which is held in place with a setscrew. I made and used a bar of this description in one repair shop, where it is still in use for light key seating. J. T.

"BOSTON TOOL" FOR MODEL WORK.

The drawing shows a little tool which I made some years ago for an odd job of model work, which was this. I wanted a shaft 9 inches long, 3-32 inch diameter, with bearing on each end ½ inch long and 1-16 inch diameter—rather an awkward job for a 16 inch lathe. So I made the "Boston tool" here described, which I found very satisfactory for the purpose, and I have since made others in different shops where they have

been accepted as the "proper thing" for making little pieces, such as special screws, counterbores, dowel pins, cores, etc., from drill rod and round stock. The large bushing is hardened and ground and may be used on ½-inch work, and bushings fitting it for smaller work. Tool *A* is a regular side tool and *B* is a cut off tool, operated by the lever *C*, which can be detached by pulling up so the pin heads may pass through the large holes at the lower ends of the slots in the lever. The



collar on the feed screw *D* turns in slots in the bottom of the tool *A*. The tools are made of ¼-inch by ½-inch stock and are an easy fit in the holder; they are gibbed at *E E*. For the convenience of any reader of MACHINERY who may wish to make himself one of these tools I have put the principal dimensions on the drawing. L. E. MUNCY.

Syracuse, N. Y.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

The following queries are referred to the readers:

22. A. R. B.—What is the specific heat of soapstone?

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23. H. L.—What is the shrinkage coefficient of plaster of paris from liquid to solid state, at ordinary temperatures? What is its expansion coefficient for heat when in the solid state? At what temperature is the "water of crystallization" driven off?

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24. T.U.V.—What is the reduction of strength in ordinary brass when subjected to temperatures higher than normal? For instance, how much thicker is it necessary to make a brass globe valve for superheated steam at, say, 600 degrees F. than for saturated steam at 350 degrees F. in order to secure the same factors of safety, the pressures being the same in each case?

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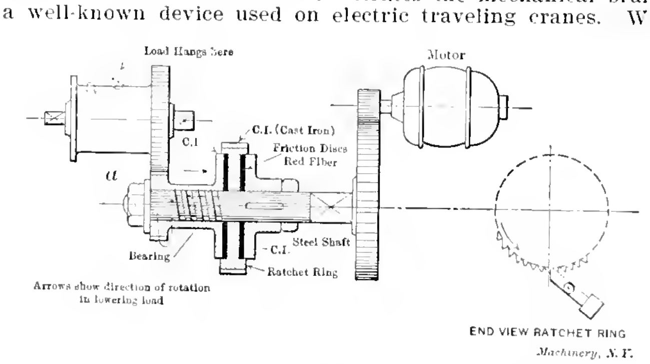
25. R. A. G.—The sketch illustrates the mechanical brake, a well-known device used on electric traveling cranes. Will



you kindly tell me how to figure the pitch of the screw *a* to hold the load; also the proper pitch which shall require the minimum amount of power to lower the load.

Answer to Question No. 16.

In reply to the inquiry in the December issue for a compound that will coat zinc black for template work, L. M. writes: "Paint will not adhere directly to zinc, as owing to a chemical action, a fine white powder or scale is deposited on the surface of the zinc, causing the paint to peel off. This can be prevented by preliminary treatment, and I feel sure that the following formula will work well: Dissolve in 64 parts of water, 1 part chloride of copper; 1 part nitrate of copper; 1 part sal ammoniac. Add to the above 1 part of commercial hydrochloric acid. Brushing the surface with this preparation will give a dead black coat, and the zinc will be ready for painting in 24 hours."

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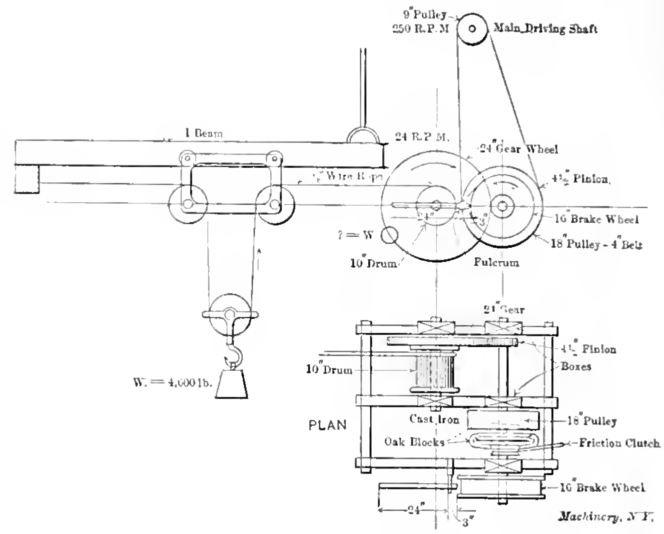
26. A. P. M.—Kindly give a demonstrated formula for finding the necessary weight to be placed upon the lever of the power hoist so as to sustain a weight of 4,600 pounds with the band brake. The brake is fitted with oak blocks of the usual V-shape working in a grooved cast-iron brake wheel. The load is lowered by gravity, and must be retarded and brought



to rest gently by the action of the brake, because of the delicacy of the work handled, being cores for the foundry. With the mechanism now in operation, I find a weight of 20 pounds on the lever enables us to handle a load of 2,000 pounds nicely and without the slightest jar. A formula submitted by another journal gave the weight of 3½ pounds to sustain the full load of 4,600 pounds.

Answered by Mr. C. F. Blake.

A. This problem cannot advantageously be put into formula shape as requested, but the solution is as follows: The first thing to be obtained is the efficiency of the machine. Formulas for this may be found in MACHINERY, Mar. and Apr., 1903. Lacking definite information as to sizes of pins and shafts, etc., we will assume 75 per cent., which will be quite near the truth if the machine is well built. We must also assume that the weight of the blocks and ropes at the lowest point is included in the 4,600 pounds, since nothing is said to the contrary. We then have 2,300 pounds on each rope, and $\frac{2,300 \times 10 \times 4.5}{24 \times 16} = 269$ pounds *net* on brake wheel. Including the frictional loss we have 269 pounds $\times$ 0.75 = 201.75 pounds, say 202 pounds on brake wheel at 75 per cent efficiency of machine. Formulas for band brakes may be found in MACHINERY for January, 1901, from which we have:

$$T = \frac{P\,b}{a\,(k-1)} \text{ in which}$$

T = weight required.
b = lever arm = 3 inches.
a = lever arm = 24 inches.
k = constant.

Data to obtain k is wanting in the sketch, but assuming the arc of contact to be 270 degrees and the coefficient of friction 0.3 we have $k = 4.11$. Then $T = \frac{202 \times 3}{24 \times 3.11} = 8.1$ pounds weight required. Owing to the variation in the coefficient of friction and the assumed efficiency of the machine it will be well to make the weight somewhat heavier than calculated, say ten pounds, and make it to slide on the lever and fasten with a setscrew, so as to be adjustable. You probably get the results described with the 20-pound weight, but you will also get the same results with a much lighter weight, since the lever and weight must be lifted to lower the load, and a man could lift considerably over-weight without losing control of the load.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

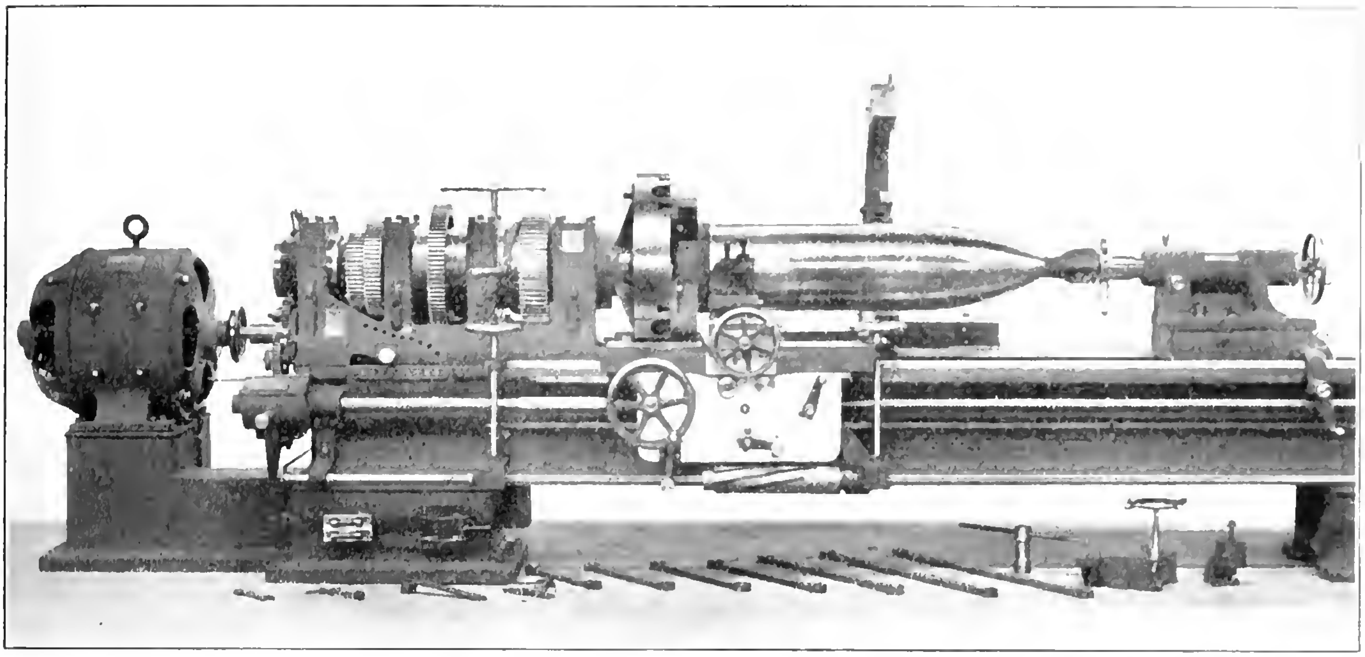


Fig. 1 Front View of Lathe showing Device beneath Carriage for Automatically Regulating Speed to Diameter

LODGE & SHIPLEY PROJECTILE LATHE.

The three half-tones herewith are illustrations of a new lathe recently brought out by the Lodge & Shipley Machine Tool Co., Cincinnati, O., which was built for them by a prominent projectile manufacturing concern. It is motor-driven, the motor used being a Ridgway 15 H. P., with speeds of 350 to 1,750. The controller has 20 speeds, and is operated from the carriage, or at the headstock. The ratio of back gearing in the head is 1.62 : 1 and 2.62 : 1; the ratio of the motor shaft to the live spindle is 7.48 : 1 and 15.1 : 1. All gearing in the head, that is, the main driving gears, has cast iron centers, with machinery steel rims of extra width. The sizes of the spindle bearings are: Front, 7 7/8 inches diameter by 8 3/4 inches; back, 7 1/2 by 5 5/8 inches. The spindle is of crucible steel .55 carbon; the hole through the spindle is 2 3/8 inches diameter. The lathe is designed at minimum speed of motor, to have a cutting speed for roughing on the body of the shell of 30 feet per minute, and for finishing of 60 feet per minute. It will be seen that the milled cylinder on the speed control shaft, immediately under the apron, provides an automatic mechanical and full electrical speed variation for varying diameters, so that the cutting speed may be continuous from 2 inches diameter up to the largest diameter.

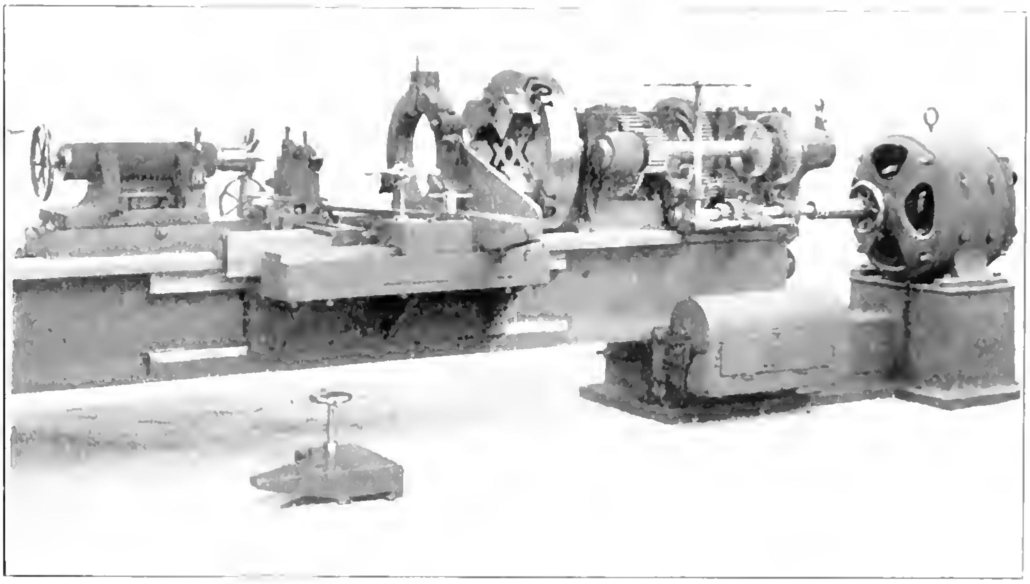


Fig. 2. Rear View showing Radius Bar for forming Points

The tool post is of steel. There is a special steady rest, which is quickly applied and removed, also the radial attachments for furnishing several desired curves. The chuck was made in the company's shop, and is of massive and substantial design. The diameter gages shown on the nose of the tailstock are great economizers of time.

The lathe here illustrated is of 27-inch swing and has a 11-foot bed, but the length of bed can be varied to suit requirements.

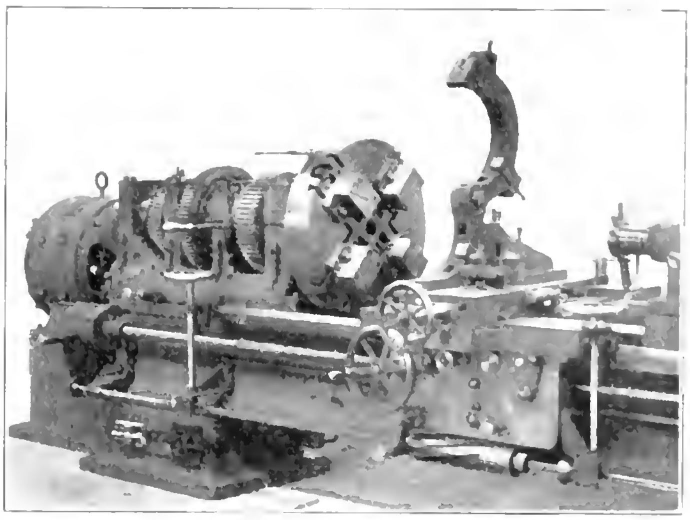


Fig. 3 Showing Massive Chuck and Special Steady Rest

MECHANICAL DRAFT APPARATUS.

The application of fans to induced draft work has made necessary many changes from the established standards of fan builders in order to avoid difficulties never met with in other lines of their work. Most fans are built with two or three spiders, and a comparatively short distance between the bearings. With this arrangement there is no deflection of the shaft and the fan wheel runs very smoothly, but when these fans have to be adapted to the handling of hot gases, the bearings must be removed from the path in which the

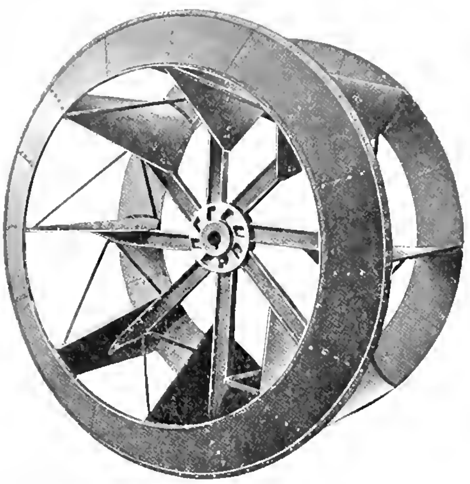


Fig. 1. Improved Fan Wheel Construction.

gases travel, as they become overheated. This necessitates either having an overhung wheel, or placing one bearing outside the inlet chamber built on the side of the fan. Unless the bearings are placed very close to the center of the fan, the overhanging will cause deflection which will work the keys loose and also cause the fan wheel to strike the housing, while the same is true of the two bearings far apart. Increasing the diameter of the shaft is not a relief, as it will deflect by its own weight. Again, the intense heat within the housing causes it to expand, and as the steel framework outside the shell is at a much lower temperature, the natural curvature is inward. Fig. 1 shows a wheel made by the American Blower Co., Detroit, Mich., with a view to overcoming these defects. The spider is made of "L" beams, which have

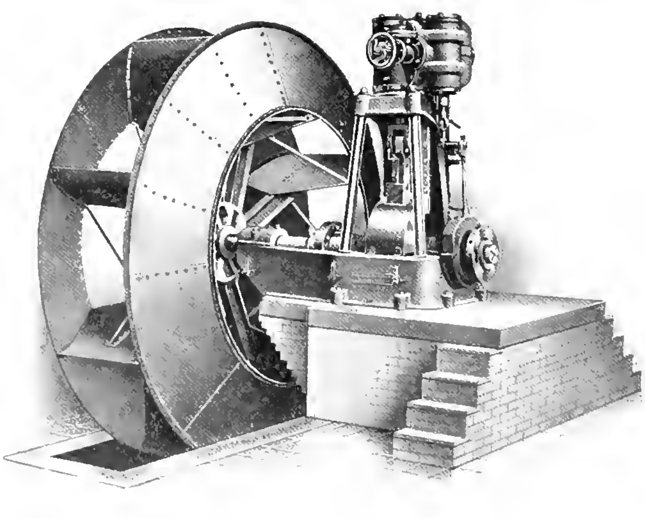
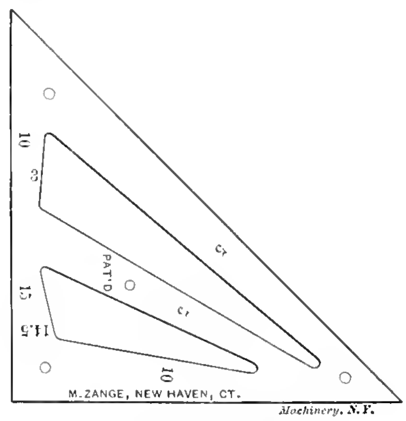


Fig. 2. Direct-connected Engine and Fan.

about three times the strength of a double set of tee arms as usually employed, and every blade is braced with bar iron braces from the outer rim to the center, thus overcoming any tendency to twisting. A very deep cone, reaching in close to the hub, is built in the side of the fan housing, while a special arm of heavy construction is built on the cantilever principle to carry the water-jacketed inner bearing, and placed at the apex of the cone. The distance from the end of the apex to the end of the projecting shaft seldom exceeds a foot. Fig. 2 shows a fan wheel mounted on a shaft with a direct coupled engine, though it is not always customary to make an extension of the base of the engine as here shown. In some cases an I-beam grillage is built into the brick foundation, the engine being set on the top of the outer ends of these beams and anchored down, and this makes practically a complete unit of the entire outfit.

IMPROVED TRIANGLE.

The illustration herewith shows a triangle made and sold by Max C. Zange, 417 Washington Avenue, New Haven, Conn. Besides the usual 90- and 45-degree angles there are two triangular spaces cut out of the triangle, the sides of which make definite angles, as indicated in the illustration. The angle between the two long sides of the lower triangle is 15 degrees, and between the sides of the upper triangle, 10 degrees. Starting at the bottom, the edge of the lower triangle makes 10 degrees with the base; and the upper edge, 25 degrees with the base. The lower edge of the upper triangle makes 30 degrees with the base, and the upper edge, 40 degrees. Turning the triangle around 90 degrees the short edge



Improved Triangle.

of the right-hand opening makes 14½ degrees with the base—an angle useful when drawing 29-degree threads on teeth. The short edge of the other opening makes 3 degrees with the base. Three small circular holes are ⅜, 5-16 and ¼ inch in diameter and are to be used in section lining, thus: Draw a section line on the 45-degree edge; put a pencil point down to the paper against one side of one of the holes and slide the triangle along the T-square till the other edge of the hole strikes the pencil; then make another line, and so on.

The triangle is provided with a small handle at the center which slides through, so that it may be used either side up and will rest flat on the paper.

STURTEVANT ENGINE.

The B. F. Sturtevant Co., Boston, Mass., have brought out a generating set consisting of a high-speed horizontal engine, direct connected to an electric generator, both of their own manufacture, and having a number of new features.

The reciprocating parts of the engine are counterbalanced with disks loaded with lead shrunk on to the crankshaft, which is a solid forging. All the main bearings are babbitted. The frame of the engine has a water sheet partition, which prevents water from the piston rod stuffing box from reaching the interior of the engine frame, and the oil on the reciprocating parts from being thrown out into the engine room. The frame is enclosed on both sides by removable plates, and the crank webs are enclosed by a cast iron hood, having two removable covers, one for the purpose of cleaning the crankpin box while it is in motion, and the other for removing the box without taking off the entire hood.

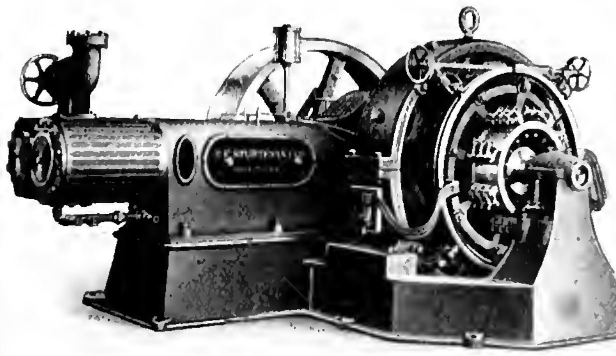
Provision is made for oiling either by the gravity or the forced pump system. In the former system, at each point where the oil is delivered are a glass gage and valve for regulating the flow at that point. With the pump, or forced lubrication system, a pump is located in the base of the engine and is operated by the crankshaft. Oil is delivered from this pump to the main bearings and from the main bearings through holes in the crankshaft and web to the crankpin. From this point the oil is conducted up through a hole in the connecting rod to the crosshead pin. A separate set of

pipes conveys the oil from the crosshead guides to the valve stem guides. The pressure of oil in the bearings under this system will vary from 12 to 13 pounds per square inch. The mechanical efficiency of the engine is so materially increased by this system of lubrication that its demand is rapidly increasing.

The engine is governed by a Rite's governor, giving very close regulation, and by adopting a modification of the Marshall valve gear an adjustment of the cut-off from zero to 70 per cent is attained.

The generator of this set is of the eight-pole type, capable of carrying momentary overloads of 50 per cent without any shifting of brushes or flashing of the commutator and an overload of 25 per cent for a period of two hours without undue heating. Before being shipped, the generator is given a breakdown test of 1,500 volts, alternating for sixty seconds between the conductors and the frame of the machine, to test the insulation.

The magnet frame is of high-grade cast iron, split horizontally. The pole pieces are of wrought iron with cast iron shoes or horns, and are secured to the magnet frame by through bolts. Any of the pole pieces may thus be removed to repair the field coils. The latter are wound up in two sections, with an air space between the shunt and series coils. The shunt winding is of double cotton-covered magnet wire with waterproof insulation. The series winding is of solid copper bars insulated in the same manner as the shunt coil.



Sturtevant Engine and Generator.

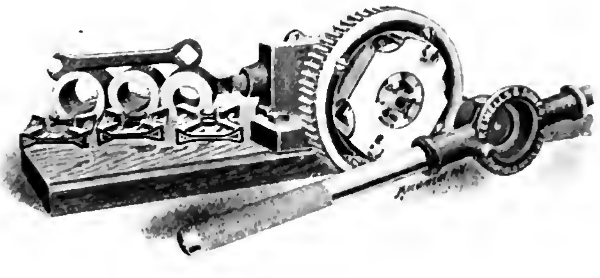
The armature is of the ironclad, form-wound, ventilated drum type, having a core built up of charcoal iron plates, japanned, mounted upon a cast-iron spider, and held by end flanges. The armature conductors are of copper bars.

In the construction of the commutator only drop-forged or drawn segments are used, these being secured in cast iron shells of spider construction and clamped in place with a steel ring. No cast segments are used. The brushes are of carbon and so proportioned as to allow at least one square inch of brush area to every 30 amperes carried. The brushes are held in holders so arranged that the entire set of brushes may be rotated completely around the commutator. Hand wheels are furnished for adjusting the brushes in position.

"WELLS" PIPE THREADING MACHINE.

The pipe threading machine illustrated herewith, for threading 1- to 2-inch pipe, is the product of the F. E. Wells & Son Co., 22 Riddell St., Greenfield, Mass. It is a very simple and compact little machine weighing about 45 pounds. It is used much like a hand diestock but it has gears to multiply the power, so that one man with this device can easily thread pipe that usually requires two with a hand stock.

The die is held in the large gear, which has a threaded shank screwing into the main frame and acting as a leadscrew to start dies. The pipe is centered by means of bushings, as in an ordinary die stock, and is prevented from turning by two vise jaws on the back of the machine operated by setscrews. All the gears are machine-cut, and the castings are of malleable iron, to save weight and yet have ample strength for the hardest usage. It can be bolted either to a bench or post, and the vise, which is a part of the machine, can be used in place of an ordinary pipe vise. With this machine the manufacturers furnish the "Economy" dies, made by them, but state that

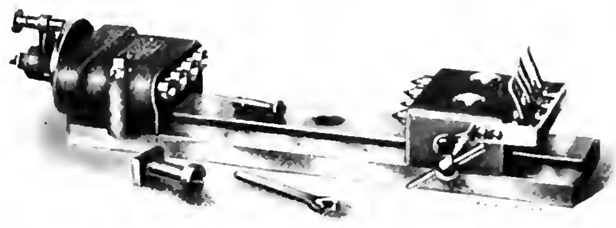


Hand Pipe Threading Machine

any standard solid square pipe die will fit. They further state that the moderate weight and small amount of work permit its being sold at a low price.

FOUR SPINDLE INDEX CENTERS WITH COLLETS.

The Garvin Machine Co., New York, have brought out a new line of multiple centers to supersede their style of centers illustrated in MACHINERY, April, 1903. For various manufacturing operations on small pieces, such at fluting, splining, flattening or squaring ends, etc., multiple centers are a valuable means of increasing production, as a number of pieces can be operated on in the same time and with the same attendance that would be required for one piece. The four-spindle center, with collet chucks, shown herewith, is for this purpose. The headstock spindles are hollow, so that work can be passed clear through, and are fitted with standard watch-lathe col-



Multiple Index Centers

lets, operated from the rear. The index dial is fixed and the spindles are indexed simultaneously by one handle. In tightening the collets, all strain is taken off the dial and pointer by locking the spindles by the binder bolt on the side. The tail-block is adjustable along the base and each spindle has an independent movement forward by a spring and is thrown back by a separate handle. The spindles are bound simultaneously by one handle. The center distance of spindles is $1\frac{1}{4}$-inch. A larger size, 2-inch centers, is also made.

NEW TOOLS OF THE THREE RIVERS TOOL CO.

The Three Rivers Tool Co., Three Rivers, Mich., have brought out several new tools for boring and drilling. One of these is the Matthews core drill, shown in Fig. 1, with blades of high-speed steel brazed into the body of soft steel. This is a modification of the Matthews reamer, described in our issue of July, 1904, but is designed for the removal of a large quantity of metal from the inside of a hole, such as a cored hole, and for this reason has deeper blades than reamers and is ground with a blunt cutting angle to prevent digging into the work, and with large grooves for chips.

This drill is made in different sizes to adapt it for the various classes of work to be done with such a tool. Since these drills are primarily for removing metal, and are followed by a reamer, they are made with a small number of flutes so that it is possible to grind them on an ordinary grinder and entirely used up. The composite construction of the drill gives all the advantages of high-speed steel at much less expense.

Core drills of this form have been used by the makers for many years, though of carbon steel, and it is found that the high-speed steel blades will render from five to six times the service of the others and at increased speed.

Another tool is a boring bar, such as has been designed and used by the Lodge & Shipley Co., Cincinnati, and shown in Fig. 3. In the description sent us the writer very pertinently calls attention to the annoyances caused by the ordinary form of boring bar and double-end cutter. Who has not had his patience sorely tried by the slot being crooked in the bar, the cutter not having a proper bearing, or, perhaps, by one of the little points used to center the cutter in the bar being broken off, or the failure of the key to fit properly? This bar has the following features, designed to overcome the usual objections:

The slot is finished complete in the machine and is central and square with the bar. The cutter has the back edge rounded to fit the slot and takes a true bearing against it. The thrust of the cut is taken against the solid metal of the bar, instead of against a key. The cutter is held to its bearing by a *transverse* key and thus avoids springing the bar; both key and slot are finished in the milling machine and the bearing in the bar is rounded like the back edge of the cutter. The transverse key serves also to center the cutter in the bar. The cutter may be sharpened until it is entirely used up without in any way affecting the centering of it, or its bearing in the bar. These cutters have been reduced to standard sizes for different diameters of bars, and may be ordered with the assurance that they will interchange. They are made of best high-speed steel.

Fig 1. New Core Drill.

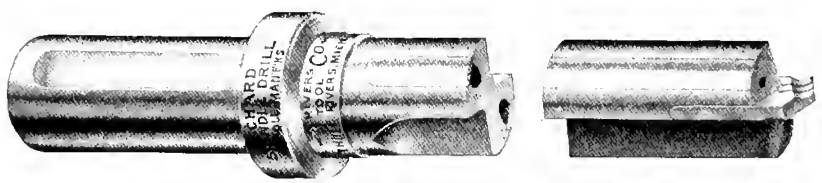


Fig 2 Deep Hole Drill

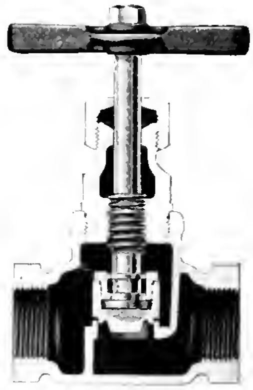

Globe Valve of the Hancock Inspirator Company.

Fig. 2 shows a tool, the outgrowth of the experience of N. D. Chard, superintendent of Lodge & Shipley Co., and used by them in drilling holes in their lathe spindles. This is being manufactured by the Three Rivers Co. It is a straight-grooved two-lip drill, provided with channels for conducting the oil or drilling compound to the point of the drill, to keep it cool and to wash out the chips. The body of the tool is of hard steel, being of unannealed tool steel in the longer lengths, to give greater stiffness. One advantage is the high-speed steel removable point, which may be changed when dull by simply knocking out a taper pin. These points are inexpensive, and the manufacturers of the drill make a small fixture for use in sharpening them. As an instance of what these drills will do, it is stated that the Lodge & Shipley Co. are drilling 1¼ inch holes in 22 spindles of 50-point carbon steel in ten hours. These spindles are 28 inches long, which makes an average of over one inch per minute for an all day's run.

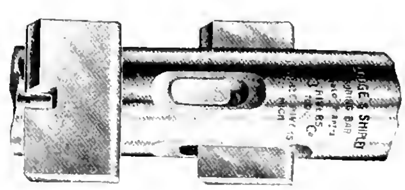


Fig 3 Boring Bar.

NEW GLOBE VALVE.

A new globe valve has been brought out by the Hancock Inspirator Co., 85-89 Liberty Street, New York, in sizes up to three inches. They are of a special composition, giving great strength and resistance to wear, and are made of the same proportions for all pressures to 4,000 pounds per square inch, and are tight under a water pressure of more than 1,000 pounds per square inch; and for 500 pounds steam pressure. The valve disks are of a special mixture not containing zinc, and the spindles are of Tobin bronze, working in a special composition bonnet, which experience has shown will not cut under high steam pressures. In this respect the experience gained in the manufacture of injectors has been made use of. Attention is called to the way in which the valve is guided upon the stem by two collars, thereby compelling the disk to sit squarely. The valve seat is flat and the valve disk has a projection on it which serves two purposes: It acts as a guiding ring when the seat is ground and prevents cutting of the seat by the wire-drawing of the steam when the valve is slightly opened. Also, as this projection is tapered slightly it allows the steam to blow out and clean the valve seat when the valve is opened.

The bonnet is made with a long thread and a narrow shoulder, by which means it is found easier to maintain a tight joint. A T-handle is employed and fits on the tapered end of the spindle, which has one side flattened to fit a taper hole of corresponding shape in the handle. There is thus no trouble from the handle working loose. When it is necessary to regrind the valve the bonnet is removed, the disk nut unscrewed and a piece of wood inserted in the disk, enabling it to be ground perfectly, as the projection on the disk guides it and no special regrinding tools are necessary.

DEVICE FOR TRUING COMMUTATORS.

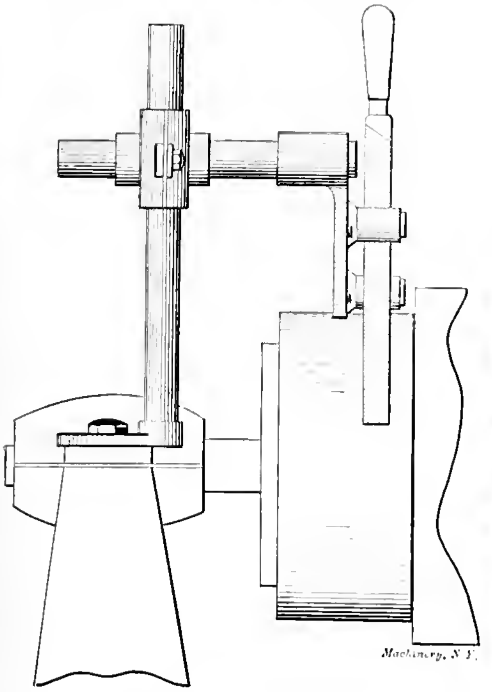
A device for truing commutators by filing has been brought out by the Excelsior Machine Works, Akron, O. The simple construction and method of attaching this device to the generator are clearly shown by cut on next page. One of its principal advantages is that no particular skill nor previous experience in truing commutators is required in order to insure satisfactory results, while the device is applicable to generators of all sizes.

The principal part is the standard, which is provided with a suitable foot by means of which it is securely attached to the generator by one of the cap bolts on the bearing. A horizontal bar is clamped at any height desired. This carries a file holder, which is moved along on the horizontal bar to meet the requirements of the commutator surface. The cutting tool is an ordinary file held in the proper position by means of the file holder. The pins, or file rests, one of which is slotted, are so located as to steady the file without the possibility of chattering.

The file, it will be seen, is moved back and forth over the commutator, and, being rigidly secured, similar to the cuttting tool in the ordinary toolpost, it cuts to a uniform depth, thus not only leveling the surface lengthwise, but restoring the true cylindrical form. Another feature is that commutators may readily be smoothed off as soon as the surface shows the first signs of becoming rough, and before it has become sufficiently uneven to warrant the removal of the armature or even the amount of metal that would ordinarily be taken off by means of a cutting tool. These little machines are manufactured at a low price.

HOLLOW HEXAGON TURRET LATHE.

The No. 3 hollow hexagon turret lathe illustrated herewith has been designed and constructed for the use of high-speed tool steels. It is made in three sizes by the Warner & Swasey Co., Cleveland, O. Fig. 1 shows a general view of the lathe and Fig. 2 an enlarged view of the turret and of the



Commutator Truing Device.

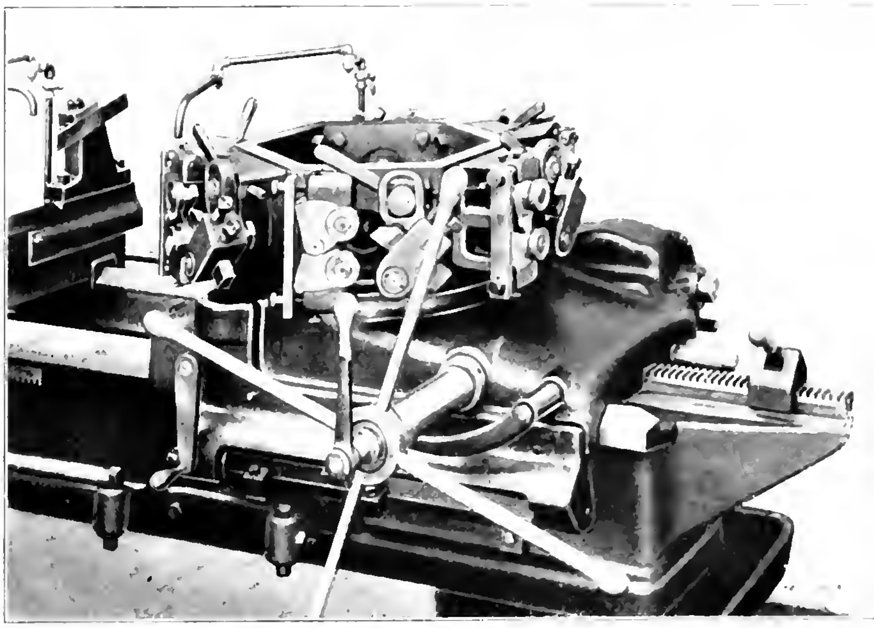


Fig. 2. Showing Turret and Tools of Hollow Hexagon Lathe.

universal turners. The head and the bed of this machine are cast in one piece. The bed is very wide and deep and the vees large.

The cone is geared 3½ to 1 and back-geared 13 to 1, the back gears being engaged and disengaged by friction clutches. There are twelve spindle speeds, ranging from 18 to 190, in geometrical progression, giving about 100 feet surface speed on diameters from 2 inches to 3⅝ inches.

The automatic chuck and the power roller feed, handle bar stock of any shape. The chuck is held in the head of the spindle, which is forged solid, thus bringing the chuck jaws close up to the front spindle bearing, with a minimum of overhang. The chuck is operated by the long lever in front of the head, working through a system of compound levers, which

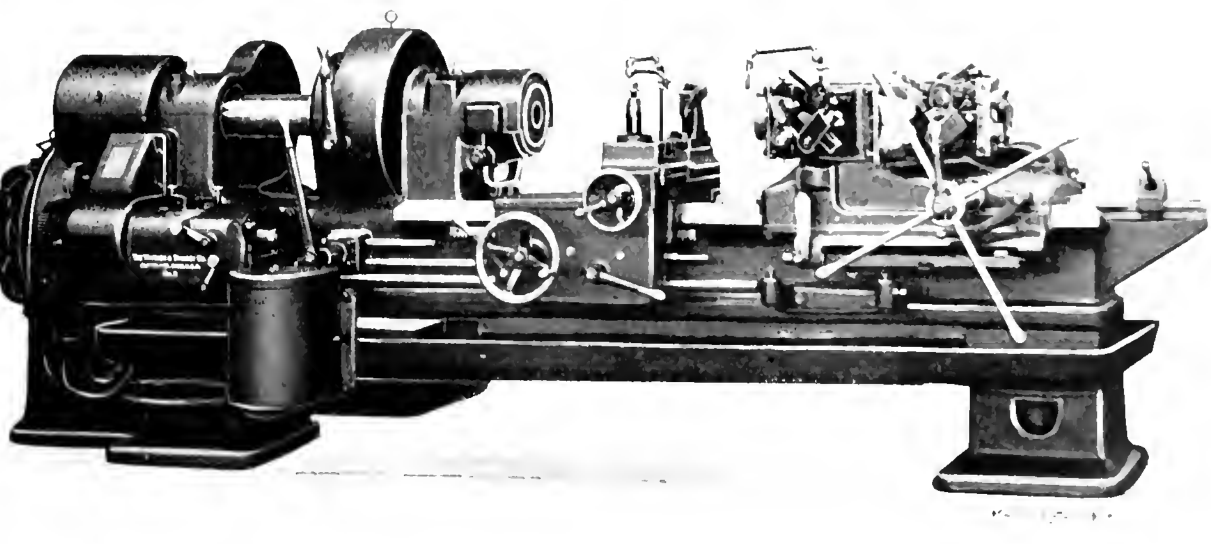


Fig. 1. Heavy Hollow Hexagon Lathe.

give a powerful movement for closing the jaws. The jaws are quickly changed for different diameters of stock and a single screw adjusts the roller feed and the guide fingers.

The turret saddle slides directly on the bed, eliminating all overhang. It is gibbed to the outer edge of the bed by flat gibs throughout its entire length. There are four changes of feed in either direction, varying from 20 to 100 (revolutions of spindle to feed one inch), and screw-cutting feeds for leading-on dies are also provided. The feed rack is located on the top of the bed, midway between the vees, as high up as possible, thus obviating the torsional strain in usual construction, where the rack is placed at the side of the bed. Power quick traverse in either direction is provided for the rapid handling of the turret, and for indexing, the movements being controlled by the lever in front of the turnstile. The independent adjustable stops for each face of the turret are located in front of the saddle, where they are easy of access for changing and adjusting, and at the same time are well protected from chips and dirt.

The hollow hexagon turret is 18 inches across flats, and has a broad bearing on the carriage. It revolves on and is kept central by a large taper bearing with ample provision for taking up wear, and its trussed form provides an exceptionally rigid support for the tools. The index is nearly the full diameter of the turret, and the lock bolt is placed directly under the working tool.

The tool equipment is adapted for a great variety of work, including thread-cutting. The universal turners are adapted for using high-speed tool steels, one of the special features of the tool being the roller back rest, which eliminates the excessive friction due to high speeds. The holder which carries the cutting tool swings about a stud, and can be accurately ad-

justed by means of a screw, while an eccentric lever provides means for quickly withdrawing the tool from the work.

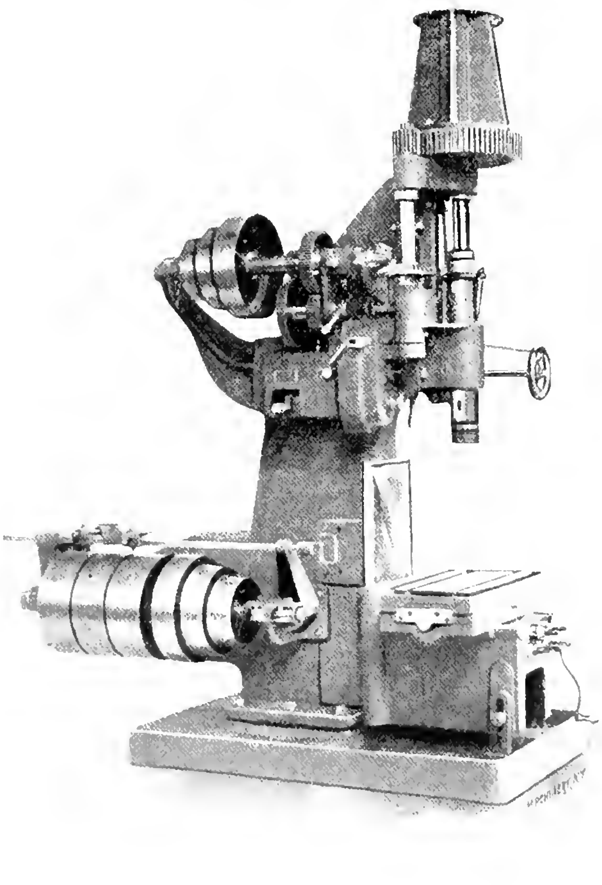
The carriage has 30 inches traverse longitudinally and 10 inches cross motion, both with four changes of feed in either direction. The longitudinal feeds vary from 24 to 120 and the cross feeds from 62 to 312 (revolutions of the spindle to feed one inch). Both feeds have adjustable automatic trips. There are two stops, with automatic trips, for the longitudinal travel; and the cross-feed screw is fitted with a graduated dial. The front of the cross-slide is equipped with a suitable toolpost for holding forming and turning tools, while the rear end carries a holder for cutting-off blades.

All the feeds are gear-driven, and are quickly and easily changed by simply shifting a lever in the feed box. The turret and carriage feeds are independent of each other. The pan and oil reservoir are large. A geared oil pump, operating in either direction, delivers a copious flow of oil to the cutting tools for both the turret and carriage, through two systems of piping. Gears and other revolving parts are covered by metal guards.

The machine shown in the photograph is electrically-driven by a variable-speed motor, direct-connected to the back gear shaft. For belt drive the spindle is equipped with a three-grade cone, and a triple friction countershaft. The net weight of this tool is about 12,000 pounds.

CYLINDER BORING MACHINE.

The half-tone herewith illustrates a new cylinder boring machine just placed on the market by Baker Bros., Toledo, O. The manufacturers call special attention to the time required to bore with this drill and give as an example a closed-end cylinder of 4⅝-inch bore, 11 inches long, upon which the time



Cylinder Boring Machine

for the roughing cut was 7½ minutes; for the second cut, 11 minutes and for reaming 3½ minutes, making the total time for the three cuts 22 minutes.

This machine is fitted with a compound table having 10 inches in and out adjustment, and 24 inches cross adjustment. The table screws are fitted with micrometers so that multiple cylinders may be accurately spaced. A gang of four of these machines has the advantages of a four-spindle machine and these machines have the same efficiency when boring out one-, two-, or three-cylinder engines that they have on four-cylinder engines. The time given above is for multiple cylinder engines where the bore must not only be perfectly true to size, but parallel besides. With independent cylinders, or with open-end cylinders, where a lower support for the boring bar is used, the time may be materially decreased.

Six changes of speed can be obtained and the machine is provided with positive geared feed, giving a range of feeds from ⅛ inch to .004 inch per revolution of spindle. It is also provided with open and cross belts and hand reverse for tapping, and with oil pump, piping and tank for receiving the surplus oil. There is an automatic stop, for stopping the feed when the spindle has reached the required depth, and all handles for operating the tables are in front, easily accessible for the operator. The main specifications of this tool are: Maximum swing, 23½ inches; diameter of spindle, 2¾ inches; vertical traverse of spindle, 4¼ inches; longitudinal movement of table, 24 inches; transverse movement, 10 inches; vertical movement, 24 inches.

NEW HENDEY-NORTON LATHE.

A lathe with special features in the way of improvements for increasing the production is illustrated herewith. It is the product of the Hendey Machine Co., Torrington, Conn.

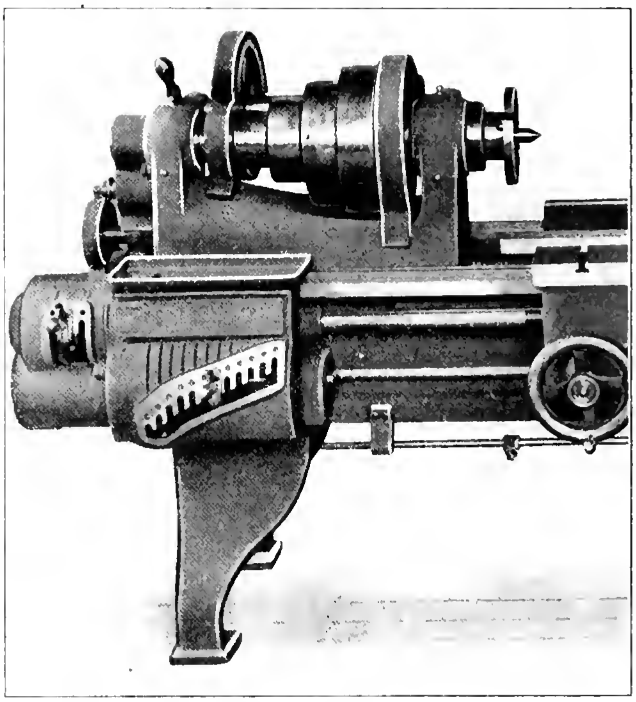


Fig 1. Headstock End of New Lathe.

Attention is called to the new compound gear box which is applied to all sizes of this lathe, from 12-inch to 20-inch swing. This combination gives a broad range of threads and feeds, approximating threads from 1½ to 80 per inch and

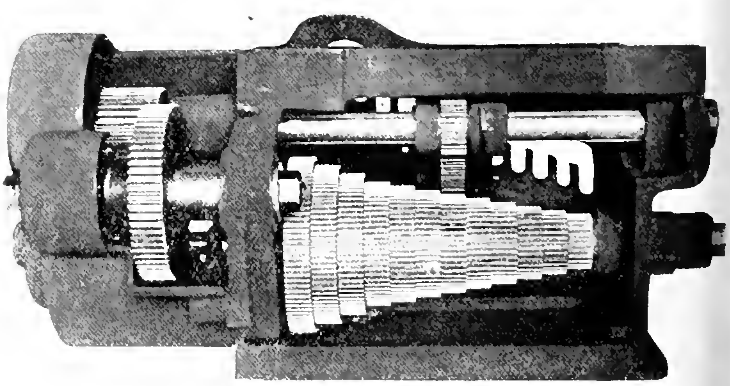


Fig. 2. Rear View of Feed Cone.

feeds from 7½ to 400 per inch. The threads available in this range are all standard pitches. Outside of this regular list of threads, the gearing on the sector of the lathe is so ar-

ranged as to be easily changed so that any special thread or threads not found on the index may be cut with special gear, which gear also works through the whole 36 combination, often cutting other useful threads.

The Hendey-Norton lathe head includes the taper bearing, self-oiling form of spindle construction with annular form of bearings carried in housings having large oil pockets in which a ring oiler for the bearing is suspended, furnishing constant lubrication to the bearings while in motion. The ample lubrication, and the rigidity of the bearings

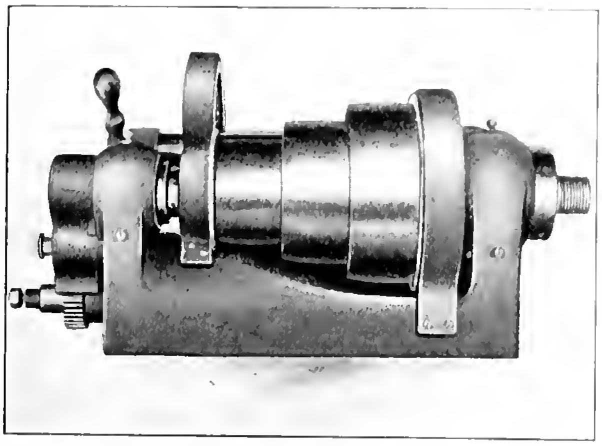


Fig. 3. Headstock Fitted with Three-step Cone for Wide Belt.

make these lathe heads long-lived in alignment and wear. The company state that an inspection and tests made of this lathe head with this form of bearing after six years' continuous service in their shops showed practically as good a bearing as when first assembled, and the alignment of the spindle was maintained with no perceptible change from the beginning.

The strength and rigidity of this lathe head make it possible to use three-step cones in place of the four-step at any time when it is desired to get more power in the spindle drive for high-speed steel work. It is to be noted that as all Hendey-Norton lathes run both belts from the countershaft in the cutting direction, the two countershaft speeds in connection with the three-step cones give 12 different spindle speeds, two more than are obtained with the ordinary type of lathe carrying five-step cones.

The addition of steel gearing wherever necessary, beds and parts made heavier than formerly, increased diameters of spindle noses for heavy chuck work, coupled with the improved features as mentioned, including the automatic stop and apron reverse for carriage, make this tool well adapted to all-around machine work as well as for tool room work.

* * *

FRESH FROM THE PRESS.

THE LAYOUT OF CORLISS VALVE GEARS. By Sanford A. Moss. Published in the Science Series by the D. Van Nostrand Co., New York. Price, 50 cents.

The basis of this little monograph is a series of articles on the lay out of Corliss valve gears contributed by Mr. Moss to the "American Machinist." It is intended as a manual for the drafting room and a complete discussion is given of the theoretical principles underlying the principles of the Corliss gear. This is followed by explicit directions for laying down the motions of a drawing board without resorting to rule-of-thumb methods. Both the single and double eccentric type of engines are taken up, although a complete theory of the latter type is not included.

LOGARITHMS FOR BEGINNERS. By Pickworth. For sale by D. Van Nostrand Co., New York. 47 pages. Price, 50 cents.

The purpose of this little book is to give a more detailed and practical explanation of logarithms and their various applications than is to be found in textbooks on algebra and trigonometry. The book is written in the clear and accurate style that has always characterized the work of Mr. Pickworth, and is to be recommended without hesitation to any one desiring to become proficient in the use of logarithms. A great many examples are worked out, both in the use of logarithms and of anti-logarithms, and there is also a discussion of logarithms having bases other than 10. It includes the treatment of hydraulic logarithms. The logarithmic tables contained in the book are quite brief and suited only to the working out of practice examples. The learner will need to have more complete tables of logarithms at his disposal.

SMOKE PREVENTION AND FUEL ECONOMY. By W. H. Booth and John B. Kershaw. Published by the Norman W. Henley Pub. Co., New York. 194 pages. Illustrated. Price, $2.50.

Mr. Booth, the well-known consulting engineer in England, has been a frequent and valued contributor to American technical journals, and his articles have been of such a character as to command the respect and attention of mechanical engineers generally. It is fair to presume, therefore, that this book will meet with just as much favor on the part of those interested in the subject of smoke prevention. The object in preparing the book was to bring before the fuel-using public a brief statement of the principles of fuel combustion, and of means for securing either complete combustion or smoke consumption, as the case may be. The book starts with the translation of the German work upon the subject by Ernst Schmatolla, and to this has been added considerable matter pertaining to both English and American practice. The treatise is brief and elementary, but apparently is comprehensive and explains methods for the examination of waste gases.

ELECTRIC FURNACES AND THEIR INDUSTRIAL APPLICATIONS. By J. Wright. Published by the Norman W. Henley Pub. Co., 132 Nassau Street, New York. 288 8-vo. pages. Illustrated. Price, $3.00.

The electric furnace is a comparatively new development in the industrial world and the magnitude of the industries that have come into existence through its use, at points like Niagara Falls where immense water powers are available, makes a study of such furnaces both desirable and necessary to those in any way connected with the manufacture of electro-chemical products. The following chapter titles will indicate the scope of the work: Arc Furnaces; Resistance Furnaces and Typical Processes; Calcium Carbide Manufacture; Iron and Steel Production in the Electric Furnace; Phosphorus Manufacture in the Electric Furnace; Glass Manufacture in the Electric Furnace; Electrolytic Furnaces and Processes; Miscellaneous Electric Furnaces and Processes; Laboratory Furnaces and Experimental Research; Tube Furnaces; Terminal Connections and Electrodes, Efficiency and Theoretical Considerations; Measurement of Furnace Temperatures.

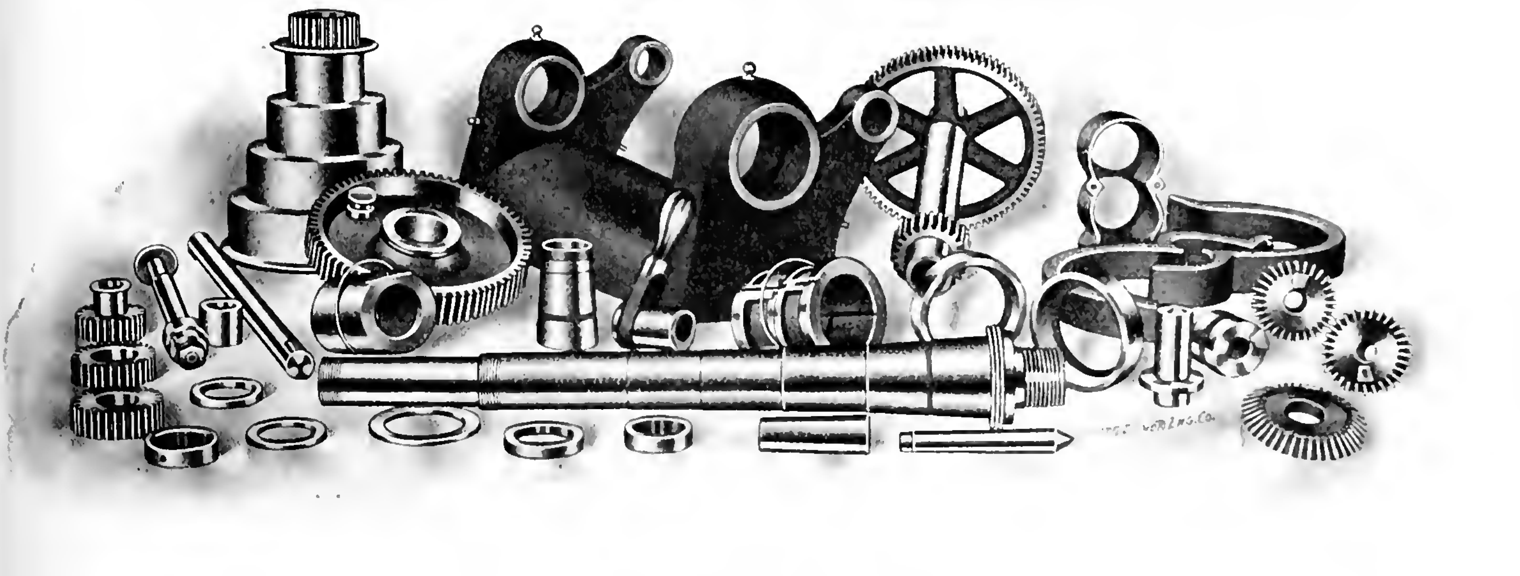


Fig. 4. View of Unassembled Lathe Head, showing the Various Parts.

STEAM BOILERS, THEIR THEORY AND DESIGN. By H. DeB. Parsons, B.S. and M.E. Published by Longmans, Green & Co., New York. 375 8vo pages. Illustrated. Price, $4.00 net. By mail $4.50.

Mr. Parsons is engaged in the work of consulting engineer, and delivers a course of lectures each year at the Rensselaer Polytechnic Institute upon steam boilers. This book covers the subject matter of the lectures and is intended to cover such points as in practical office work may be found to be perplexing. The book is largely descriptive, such mathematics as are used being extremely simple, and it treats of the subjects of combustion, fuels, boiler settings, chimneys, boiler auxiliaries, mechanical stokers, smoke prevention and superheaters, besides the treatment of the boiler itself and the materials entering into it. The illustrations are all made especially for this work and are unusually clear. They number over 150. The book is to be recommended to anyone desiring a complete but elementary treatise on the steam boiler. We are inclined to think it contains practically all the information that even the designing engineer would need to have at his disposal.

DIMENSIONS OF PIPE, FITTINGS AND VALVES. By W. D. Browning. Published by the Draftsman Co., Cleveland, O. 82 8-vo. pages. Illustrated. Price, 75 cents.

This little book is one of the most useful compilations of data for draftsmen that we have seen. It gives exactly the information that any one having to lay out piping would wish to have at his disposal. It is a compilation of tables on iron, lead and spiral riveted pipe, cast iron pipe, drain pipe, etc. These tables include dimensions and particulars in regard to the pipe itself, to their fittings, valves and

miscellaneous articles that go into pipe work. Not only the usual tables to be found in engineers' handbooks and catalogues of pipe manufacturers are here given but also dimensions such as draftsmen need, like for example, the principal dimensions of valves, elbows, tees and other fittings; boiler fittings, such as water columns, gages, injectors, etc.; also particulars in regard to laying out piping for steam-heating bath rooms, etc. It would be highly desirable to have more books of this sort upon other subjects, containing similar data for ready reference.

ELEMENTS OF MECHANICAL DRAWING. By Alpha Pierce Jamison, M.E. Published by John Wiley & Sons, New York. 226 8vo. pages. Illustrated. Price, $2.50.

This book has been developed at Purdue University for instructing first-year students in technical schools, and embraces those branches necessary to give the student such knowledge as will prepare him to pursue a course in engineering. It appears as though at this late day students in drawing would have no difficulty in securing text-books adapted to their needs. This is a well-written and carefully illustrated volume which becomes another addition to the many excellent treatises on drawing. The illustrations are unusually good and the subject matter is grouped under the following headings: Elementary Principles and Definitions; Letters, Figures and Lettering; Projection; Drawing Tools and Materials; Reproduction of Drawings; Patent Office Drawings; Gearing; Color Work; Sketching; The Mechanical Execution of Drawings. The chapter on lettering offers good suggestions; the one on projection is rather brief in its treatment, as is also the one on gearing. The chapter upon the mechanical execution of drawings takes up quite fully the characteristics of working drawings.

ELEMENTS OF GENERAL DRAFTING FOR MECHANICAL ENGINEERS. By C. E. Coolidge, assistant professor, and H. L. Freeman, instructor, in the mechanical department of machine design, Sibley College, Cornell University. Published by John Wiley & Sons, New York. Size, 9 x 12. 51 pages. Illustrated with 21 folding plates. Price, $2.50.

Messrs. Coolidge and Freeman have treated the subject of working drawings exclusively in this textbook, giving what we suppose to be the course of Sibley College upon this subject. As a treatise in the production of working drawings it easily stands as one of the most complete that has appeared. No attempt is made to include anything upon machine design, but rather to show by well-executed plates and suitable descriptive matter what conventional and mechanical drawing are, and how working drawings of different subjects are to be made. The plates include full details of a pillar shaper besides a number of engine parts, to show how machine details should be laid out. In addition there is a plate showing a lay out for piping, one showing engine foundations with templet for anchor bolts, one showing a plan of a building, one in isometric projection and a patent office drawing. The book describes the selection, use and care of materials and instruments for drawing, and the student is shown how to put in a definite form a standard drafting room system which has been worked out by the authors after careful study of many systems.

ELEMENTS OF MECHANISM. By Peter Schwamb, S.B., and Allyne L. Merrill, S.B. Published by John Wiley & Sons, New York. 264 8vo pages. Illustrated. Price, $3.00.

The main subject matter of this work was written nearly twenty years ago by Prof. Schwamb, and has since been used in the form of published notes for instruction in mechanism in the Massachusetts Institute of Technology. Inasmuch as calls were made for the notes from other schools, and it was decided to revise them, they are now brought out in book form. The book, as its name implies, deals almost entirely with elementary motions entering into the mechanism of machine parts. The treatment of the various elements follows closely the plan outlined many years ago by Prof. Reuleaux, but—and this seems to us a decided advantage—these methods have not been followed to the extreme position taken by many writers on mechanism who, in the attempt to be logical, treat the subject in a way that not only would not appeal to practical men who are largely responsible for the various mechanisms treated, but that would be positively confusing to them. The subjects of centroids, instantaneous centers, etc., receive proper recognition, but the book is not filled with such terms. The subjects of cams, parallel motions, crank motions, quick return motions, escapements, trains of gearing such as found in engine lathes, clocks, cotton machinery, etc., and epicyclic gearing appear to be treated very completely. The chapter on speed cones merely takes up the mathematical calculation of the length of belts without giving any of the recent graphical methods developed for laying out such cones. While the book professes to deal only with the elements of mechanism there is a chapter entitled "Aggregate Combinations" in which are shown a few combinations of moving parts, and the book would seem more complete if there had been included in this chapter some of the recent important mechanical movements that have been developed, such for example, as the speed cone arrangements so universally employed in machine tools. Following the treatment of mechanism are about 75 pages on the subject of gearing, showing how to lay out gear teeth. This part appears to be unusually complete.

MANUFACTURERS' NOTES.

THE GRAHAM MFG. CO., Providence, R. I., report that fire recently destroyed most of their stock (over 200 vises), but that they will be able to fill orders that come.

THE JACOBSON MACHINE MFG. CO., Warren, Pa., have just completed a line of patterns for an automatic gas engine in sizes from 5 to 200 H. P., of which they will be glad to furnish full description to any one interested.

THE RAND DRILL CO., New York, report that the United States Government have just purchased from them twenty-seven "Imperial" pneumatic hammers and drills, to be used in connection with the Manila harbor improvements.

THE NORTHERN ELECTRICAL MFG. CO., Madison, Wis., report the following orders recently received: A 200-K. W. Northern generator; Northern dynamos and motors for use in brewing work; three 150-K. W. slow-speed generators, etc.

GEORGE WILLIAM HOFFMAN, Indianapolis, Ind., announces that the "U. S. Metal Polish and Bar Keeper's Friend" received the highest award at the Chicago World's Fair in 1893 and also at the Louisiana Purchase Exposition this year.

THE STANDARD ROLLER BEARING CO., Philadelphia, Pa., have just doubled the size of their plant, have been running all night almost constantly for the past two years. They have just purchased a tract 300 feet by 20 feet for another addition to their foundry.

THE HAYES FILE CO., Detroit, Mich., have just purchased all the machinery and tools of the Simonetta File Co., which was organized in Detroit last May with a capital of $25,000 to manufacture files under a secret process. The Hayes File Co. expect to catch up with their orders as soon as they get the above machinery installed.

THE MASSACHUSETTS TOOL CO., Greenfield, Mass., are offering as a special bargain, from the first of the year till March 15, 1905, four tempered steel rules (one each) 2-inch, 3-, 4- and 6-inch, for $1.00. The accuracy of these rules is guaranteed, and they will be sent to any part of the United States on receipt of the above price.

THE WATSON-STILLMAN CO., New York, announce, with regard to their recent fire, that at present some of their tools are running and that through the courtesy of some of their friends, whose shops have been thrown open to them, they have been enabled to take care of their customers promptly.

THE STOW FLEXIBLE SHAFT CO., Philadelphia, Pa., report the following recent orders: A Halsey portable drill for a firm in Vancouver; an 18 foot flexible shaft and a large crankpin turning machine; also three complete electric hammer outfits, shipped to Italy, for use in the Government navy yards.

THE GARRY IRON & STEEL CO., Cleveland, O., recently shipped ten 30-ton pneumatic jacks, a hand power jib crane and a pneumatic jib crane to three customers. Their recent orders include a 3,000-pound revolving pneumatic crane, mounted on car, and six 1-ton buckets; a 5,000-pound revolving electric locomotive crane; a 15-ton hand power pillar crane; and one 6-ton hand power overhead traveling crane.

W. S. ROGERS, Supt. Philadelphia Bourse, Philadelphia, advises us that the following concerns recently rented space and placed their products on exhibition in the Bourse Exhibition: the Murray Iron Works, engines; the N. C. Lane Co.; Collins damper, regulators, oil filters, etc.; Germania Lamp Co., electric lamps; J. H. Lake & Vaughn Bros., gas and gasoline engines and launches; E. H. Godshalk Co., gas and gasoline engines and launches; Egry Autographic Registering Co., registers and the Egry merchandise systems; Philadelphia Gear Wks. (formerly Grant Gear Wks.), system of gearing; Novelty Tool Mfg. Co., Keystone combination tools, forge, drill, etc.; Pittsburg Fuel Saving Furnace Co., grate and smoke consuming furnace; Frank B. Smith, patent pneumatic despatch apparatus.

THE CROCKER-WHEELER CO., Ampere, N. J., who have recently become licensees of Brown-Boveri & Co., Baden, Switzerland, for their alternating current apparatus, announce the sale of three 4,000 K. W. alternators to the California Gas & Electric Corporation, of San Francisco. These are to be three-phase, 13,000-volt, 25-cycle, 83 R. P. M., revolving field alternators. They are to be driven by 6,000 H. P. gas engines built by the Snow Gas Engine Co., and will be the largest alternators ever built for gas-engine service. They are to furnish power for operating all the street railways in San Francisco and vicinity. This is the first important sale made by the Crocker-Wheeler Co. since acquiring the rights to manufacture apparatus under the Brown-Boveri patents.

NEW TRADE LITERATURE.

Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes.

THE F. BISSELL CO., Toledo, O. Catalogue showing electric toys, motors and novelties, copy of which will be sent on request.

E. F. HOUGHTON & CO., Philadelphia, Chicago and Detroit. New catalogue illustrating the various methods of installing the Marck steam trap, for the economical use of steam, preventing freezing of pipes, and obtaining uniform heat at a minimum pressure. Mailed free to any one writing to their Philadelphia address, 240 W. Somerset Street.

THE COATES CLIPPER MFG. CO., Worcester, Mass. Bulletin No. 18 treating of the Coates flexible transmission. Herein are illustrated the unit-link, ball-bearing flexible shaft; also housed gear breast drills; the Coates drill press, made in three sizes; a magnetic hold-on; a die-sinker's engine, with Coates patent multiplier; a friction drive center grinder, etc., all using the Coates flexible transmission. Special attention is called to the Coates angle drive, which is new.

THE LUCAS MACHINE TOOL CO., Cleveland, O. Clever little pamphlet entitled "Why Does a Dog Waggle His Tail?" to which the answer is because "the dog is bigger than the tail," and the argument is put forth that raising and lowering a heavy piece of work in a boring machine is like "the tail wagging the dog," and that it is better to raise and lower the spindle; which is how it is done with the "Precision" boring, drilling and milling machine of this company.

THE CHICAGO PNEUMATIC TOOL CO., Chicago and New York. Catalogue, standard size, of pneumatic tools. Among these are listed the Boyer riveting hammers, chipping, calking and beading hammers, piston air drills, angle gears; the "Little Giant" flue-rolling, reaming and tapping machines; the improved "Chicago" air forge; rock drills, pneumatic motors and geared hoists, special air hoists, etc., etc. The catalogue appears to be very complete and will give a good idea of the products of this company. There are a large number of illustrations.

THE GISHOLT MACHINE CO., Madison, Wis. Illustrated catalogue, 8 x 10, of boring mills. A few sizes of the general line of vertical and horizontal mills are shown. A 34-inch vertical boring mill, with plain head and with swivel head; a 42-inch vertical boring mill with two swivel heads, and one with turret head; the 52-, 60-, 64- and 72-inch vertical boring mills; a horizontal mill; the "Gisholt" turret lathe and the "Gisholt" tool grinder. Brief descriptions accompany the very fine illustrations of each of these tools. The catalogue is printed on heavy coated paper and is a most creditable piece of work.

THE DERRY-COLLARD CO., 256 Broadway, New York. "Books and Things, No. 2," a pamphlet listing technical books. These treat of machinery, electricity, civil and steam engineering, pattern and foundry work, marine work, woodworking, plumbing and heating. There are also books on drawing and a list of the new books just out. Attention is called to the "D-C Book Club," by which plan one may buy any books or papers by paying $1, $2, $3 or $5 a month. The "Book Club Folder" explains this fully and will be sent to any one interested. This company also send on approval any mechanical book costing $1 or more, which may be returned if not satisfactory.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order.

MACHINERY.

February, 1905.

ROLLER CHAIN POWER TRANSMISSION AND CONSTRUCTION OF SPROCKETS.

A. EUGENE MICHEL.

A. Eugene Michel.

Machined chains and milled sprockets have but recently attained their present high standard. It is therefore not strange that the engineering literature of this country and Europe contains little valuable information concerning them. Ignorance and neglect of mechanical laws have resulted, and the users of chain drives have been subjected to difficulties, many of which may be eliminated by proper construction.

Steel chain of accurate pitch, high tensile strength, and good wearing qualities, possesses, when used within proper limitations, advantages enjoyed by no other form of transmission. It is compact, affords an absolutely positive speed ratio, and at slow speeds is capable of transmitting heavy strains. On short transmissions it is more efficient than belting, and will operate more satisfactorily in damp or oily places. There is no loss of power from stretch, and as it allows of a low tension, journal friction is minimized. The first cost is little more than that of belting for the same duty. Sprockets cost more than pulleys, but admit of great reduction in size and weight.

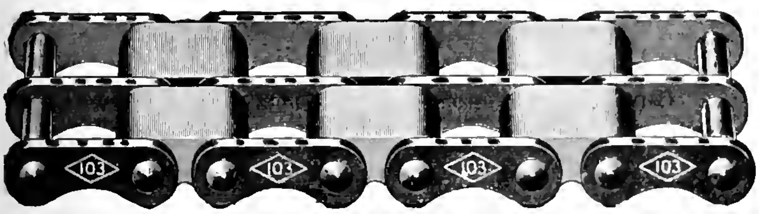


Fig. 1. Double-width Block Chain.

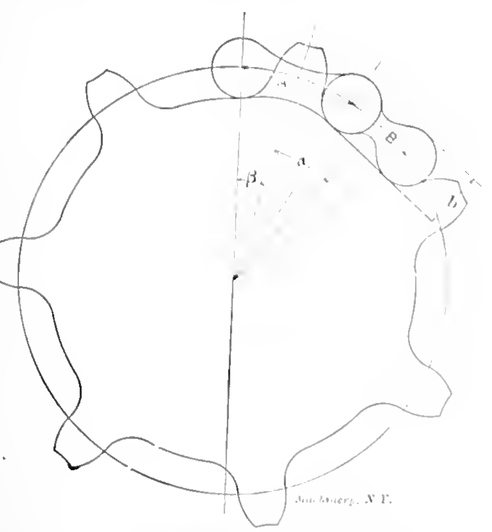


Fig. 3. For obtaining Pitch, Bottom and Outside Diameters of a Block Chain Sprocket.

Roller chain has been known to stand up at a speed of 2,000 feet per minute, and transmit 25 horse power at 1,250 feet per minute; but speeds of 1,000 feet per minute and under, give better satisfaction. Block chain is adapted to slower speeds, say 700 feet per minute and under, and is extensively used on bicycles, small motor cars and machine tools. Where speed and pull are not fixed quantities, it is advisable to keep the speed high, and chain pull low, yet it should be borne in mind that high speeds are more destructive to chains of large, than to those of small pitch.

The following table of tensile strengths, based on tests of "Diamond" chains taken from stock, may be considered a fair standard:

ROLLER CHAIN

Pitch.	Tensile Strength, Pounds.	Pitch.	Tensile Strength, Pounds.
1/2 inch	1,200	1 1/4 inch	9,000
5/8 inch	1,200	1 1/2 inch	12,000
3/4 inch	4,000	1 3/4 inch	19,000
1 inch	6,000	2 inch	25,000
BLOCK CHAIN			
1 inch	1,200 to 2,500	1 1/2 inch	5,000

It is a common fallacy that the safe working load of a chain is close to the ultimate tensile strength. The safe working load is dependent on the amount of rivet bearing surface, and varies from 1-5 to 1-40 of the tensile strength, according to the speed, size of sprockets, and other conditions peculiar to each case. The tendency now is to use the widest possible chain in order to secure maximum rivet bearing surface, thus insuring minimum wear from friction. In the last few years manufacturers have been making heavier chains than heretofore for the same duty. As short pitch is always desirable for high or low speeds, special double and even triple-width chains are now made to conform to the requirements when a heavy single width chain of greater pitch is not practical. Fig. 1 represents such a double chain having twice the rivet bearing surface and half again as much tensile strength as the similar single one.

Fig. 2. For Calculating Exact Length of Chain for a given Drive

The exact length of chain for a given drive is not so easily obtained as it seems at first sight. The following formula will be found useful: (See Fig. 2.)

All dimensions in inches.

D = Distance between centers of shafts.

A = Distance between limiting points of contact

R = Pitch radius of large sprocket.

r = Pitch radius of small sprocket.

N = Number of teeth of large sprocket

n = Number of teeth of small sprocket

P = Pitch of chain and sprockets.

$(180 + 2a)$ (see Fig. 2) = angle of contact on large sprocket

$(180 - 2a)$ = angle of contact on small sprocket.

$$a = \sin^{-1}\frac{R - r}{D}$$

$$A = D\cos a$$

A. EUGENE MICHEL was born in St. Louis, Mo. 1880. He is a graduate in mechanical engineering of the Rose Polytechnic Institute. Since graduation he spent two years in the engineering department of the Federal Mfg. Co.'s diamond chain factory. He resigned his position with this concern to take charge of the new testing department of the Ewart Mfg. Co., Indianapolis, Ind., and will there direct tests of the Renold silent chain and detachable link belting.

Length of chain required.

$$L = \frac{180 + 2\,a}{360}\,N\,P + \frac{180 - 2\,a}{360}\,n\,P + 2\,D\cos a$$

For *block* chain, the total length specified in ordering should be in multiples of the pitch. For *roller* chain, the length should be in multiples of twice the pitch, as a union of the ends can be effected only with an outside and an inside link.

PITCH DIAMETERS FOR ROLLER CHAIN SPROCKETS.

No. of Teeth.	½" P	⅝" P.	¾" P.	1" P.	1¼" P.	1½" P.	1¾" P.	2" P.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
8	1.307	1.634	1.960	2.613	3.266	3.921	....	....
9	1.462	1.827	2.193	2.924	3.655	4.386	5.117	....
10	1.618	2.022	2.427	3.236	4.045	4.854	5.663	6.472
11	1.775	2.218	2.662	3.549	4.438	5.324	6.212	7.100
12	1.932	2.415	2.898	3.864	4.830	5.796	6.761	7.728
13	2 089	2.612	3.134	4.179	5.224	6.268	7.313	8.358
14	2.247	2.809	3.370	4.494	5.618	6.741	7.864	8.988
15	2.405	3.007	3.607	4.810	6.013	7.215	8.417	9.620
16	2.563	3.204	3.844	5.126	6.408	7.689	8.970	10.252
17	2.721	3 401	4.081	5.442	6.803	8.164	9.524	10.884
18	2.879	3.559	4.319	5.759	7.199	8.638	10.078	11.518
19	3.038	3.797	4.557	6.076	7.595	9.114	10.632	12.152
20	3.196	3.995	4.795	6.393	7.991	9.589	11.187	12.786
21	3.355	4.193	5.033	6.710	8.388	10.064	11.742	13.420
22	3.513	4.392	5.271	7.027	8.784	10.539	12.297	14.054
23	3.672	4.590	5.508	7.344	9.180	11.016	12.852	14 688
24	3.831	4.788	5.746	7.661	9.576	11.492	13.407	15.322
25	3.989	4.987	5.984	7.979	9.974	11.968	13.963	15.958
26	4.148	5.185	6.222	8.297	10.371	12.444	14.518	16.594
27	4.307	5.384	6.460	8.614	10.768	12.921	15.074	17.228
28	4.465	5.582	6 698	8.931	11.164	13.397	15.629	17.862
29	4.624	5.781	6.936	9.249	11.561	13.873	16.186	18.498
30	4.783	5.979	7.175	9.567	11.958	14.350	16.742	19.132
31	4.942	6.178	7.413	9.884	12.355	14.826	17.298	19.768
32	5.100	6.376	7.652	10.202	12.753	15.303	17.853	20.404
33	5.260	6.575	7.890	10.520	13.150	15.780	18.409	21.040
34	5.419	6.774	8.129	10.838	13.548	16.257	18.966	21.676
35	5.578	6.972	8.367	11.156	13.945	16.734	19.522	22.312
36	5.737	7.171	8.605	11.474	14.343	17.211	20.078	22.948
37	5.896	7.369	8.844	11.791	14.739	17.687	20.634	23.581
38	6.055	7 568	9.083	12.110	15.138	18.165	21.191	24.220
39	6.214	7.767	9.321	12.427	15.534	18.641	21.747	24.854
40	6.373	7.966	9.560	12.746	15.933	19.119	22.304	25.492
41	6.532	8.165	9.798	13.064	16.330	19.596	22.861	26.128
42	6.691	8.363	10.037	13.382	16.728	20.073	23.418	26.764
43	6.850	8.562	10.274	13.699	17.124	20.548	23.974	27.398
44	7.009	8.761	10.512	14.018	17.523	21.027	24.530	28.036
45	7.168	8.959	10.751	14.335	17.919	21.503	25.086	28.670
46	7.327	9.158	10.990	14.653	18.316	21.980	25.643	29.306
47	7.486	9.358	11.229	14.972	18.715	22.458	26.201	29.944
48	7.645	9.557	11.468	15.291	19.114	22.937	26.758	30.582
49	7.804	9.755	11.706	15.608	19.510	23.412	27.314	31.216
50	7.963	9.954	11.945	15.927	19.909	23.891	27.871	31.854
51	8.122	10.153	12.184	16.244	20.305	24.366	28 427	32.488
52	8.281	10.351	12.422	16.562	20.703	24.843	28.983	33.124
53	8.440	10.550	12.661	16.880	21.100	25.320	29.541	33.760
54	8 600	10 750	12.900	17.200	21.500	25.800	30.099	34.400
55	8.759	10.949	13.137	17.516	21.895	26.274	30.656	35.032
56	8.917	11.147	13.379	17.835	22.294	26.753	31.211	35.670
57	9.076	11.345	13.614	18.152	22.690	27.228	31.766	36.304
58	9.235	11.544	13.853	18.471	23.089	27.707	32.323	36.942
59	9.395	11.743	14.093	18.790	23.488	28.185	32.882	37.580
60	9.553	11 941	14.329	19.105	23.881	28.658	33.435	38.210
61	9.714	12.142	14.572	19.429	24.286	29.144	34.000	38.858
62	9.873	12.342	14.807	19.743	24.679	29.615	34.554	39.486
63	10.030	12.538	15.045	20.060	25.075	30.090	35.106	40.120
64	10.189	12.737	15.281	20.379	25.474	30.569	35.663	40.758
65	10.350	12.937	15.525	20.700	25.875	31.050	36.224	41.400
66	10.508	13.136	15.793	21.017	26.271	31.526	36.780	42.034
67	10.666	13.332	15.998	21.331	26.664	31.997	37.330	42.662
68	10.827	13.534	16.241	21.654	27.068	32.481	37.895	43.308
69	10.987	13.733	16.480	21.973	27.466	32.960	38.453	43.946
70	11.146	13.932	16.719	22.292	27.865	33.438	39.010	44 584
71	11.304	14.131	16.958	22.609	28.261	33.914	39.566	45.218
72	11.463	14.328	17.194	22.925	28.656	34.388	40.119	45.850
73	11.620	14.525	17.430	23.240	29.050	34.860	40.669	46.480
74	11.779	14.723	17.668	23.557	29.446	35.336	41.225	47.114
75	11.939	14.923	17.908	23.878	29.848	35.817	41.786	47.756

Wherever possible, the distance between centers of shafts should permit of adjustment in order to regulate the sag of the chain. A chain should be adjusted, in proportion to its length, to show slack when running, care being taken to have it neither too tight nor too loose, as either condition is destructive. If a fixed center distance must be used, and results in too much sag, the looseness should be taken up by an idler, and when there is any considerable tension on the slack side, this idler must be a sprocket. Where an idler is not practical, another combination of sprockets giving approximately the same speed ratio may be tried, and in this manner a combination giving the proper sag may always be obtained.

In automobile drives, too much sag or too great a distance between shafts causes the chain to whip up and down—a condition detrimental to smooth running and very destructive to the chain. In this class of work a center distance of over four feet has been used, but greater efficiency and longer life are secured from the chain on shorter lengths, say three feet and under.

Properly proportioned and machined sprockets are essential to successful chain gearing. Sprocket cutting is not difficult, yet strange to say, most American practice is bad. Hence the writer presents these formulas and data to enable any manufacturer to do this work correctly, and at little cost.

The important dimensions of a sprocket are the pitch diameter and the bottom and outside diameters. For block chain these are obtained as follows: (See Fig. 3.)

N = No. of teeth.

b = Diameter of round part of chain block.

B = Center to center of holes in chain block.

A = Center to center of holes in side links.

BLOCK CHAIN SPROCKET DIAMETERS.

Standard Bicycle Chain, 1" Pitch. Diam. of round part of block = .325".			Number of Teeth.	Standard Block chain, 1½" Pitch. Diam. of round part of block = .532".		
Pitch Diam.	Outside Diam.	Bottom Diam.		Pitch Diam.	Outside Diam.	Bottom Diam.
Inches.	Inches.	Inches.		Inches.	Inches.	Inches.
1.935	2.260	1.610	6	....	....	....
2.250	2.575	1.925	7	....	....	....
2.564	2.889	2.239	8	....	....	....
2 882	3.207	2.557	9	4.323	4.730	3.791
3.198	3.523	2.873	10	4.798	5.205	4.266
3.514	3.839	3.188	11	5.274	5.681	4.742
3.832	4.157	3.507	12	5.749	6.156	5.217
4.150	4.475	3.825	13	6.224	6.693	5.692
4.467	4.792	4.142	14	6.701	7.170	6.169
4.785	5.110	4.460	15	7.177	7.646	6.645
5.103	5.428	4.778	16	7.654	8.123	7.122
5.420	5.745	5.095	17	8.130	8.662	7.598
5.743	6.068	5.418	18	8.607	9.139	8.075
6.056	6.381	5.731	19	9.084	9.616	8.552
6.373	6.698	6.048	20	9.561	10.093	9.029
6.691	7.016	6.366	21	10.039	10.571	9.507
7.008	7.333	6.683	22	10.516	11.048	9.984
7.327	7.652	7.002	23	10.993	11.525	10.461
7.647	7.972	7.322	24	11.469	12.001	10.937
7.966	8.291	7.641	25	11.946	12.478	11.414
8.284	8.609	7.959	26	12.422	12.954	11.890
8.602	8.927	8.277	27	12.900	13.432	12.368
8.919	9.244	8.594	28	13.376	13 908	12.844
9.236	9.561	8.911	29	13.856	14.388	13.324
9.556	9.881	9.231	30	14.330	14.862	13.798
9.874	10.199	9.549	31	14.810	15.342	14.270
10.192	10.517	9.867	32	15.286	15.818	14.754
10.510	10.835	10.185	33	15.764	16.296	15.232
10.828	11.153	10.503	34	16.245	16.777	15.713
11.146	11.471	10.821	35	16.720	17.252	16.188
11.464	11.789	11.139	36	17.196	17.728	16.664
11.782	12.107	11.457	37	17.669	18.201	17.137
12.100	12.425	11.775	38	18.151	18.683	17.619
12.418	12.743	12.093	39	18.627	19.159	18.085
12.736	13.061	12.431	40	19.105	19.637	18.573
			41	19.584	20.116	19.052
			42	20.062	20.594	19.530
			43	20.532	21.064	20.000
			44	21.015	21.547	20.483
			45	21.488	22.020.	20.956
			46	21.966	22.498	21.434
			47	22.450	22 982	21.918
			48	22.933	23 465	22.401
			49	23.408	23.940	22.876
			50	23.879	24.411	23.347

$$a = \frac{180^\circ}{N}$$

$$\operatorname{Tan}\beta = \frac{\sin a}{\dfrac{B}{A} + \cos a}$$

$$\text{Pitch diameter} = \frac{A}{\operatorname{Sin} \beta}$$

Bottom diameter = pitch diameter − b.
Outside diameter = pitch diameter + b.

For roller chain: (See Fig. 4.)

N = Number of teeth.
P = Pitch of chain.
D = Diameter of roller.

$$a = \frac{1}{2}\ \frac{360}{N}$$

$$\text{Pitch diameter} = \frac{P}{\sin a}$$

Bottom diameter = pitch diameter − D.
For sprockets of 17 teeth and over,

Outside Diam = Pitch Diam. + D.

The outside diameter of smaller sprockets are cut down so that the teeth will clear the roller perfectly at high speeds.

Outside Diam. = Pitch Diam. + D − E.

Pitch.	Values of E. 8 to 12 Teeth.	13 to 16 Teeth.
½ inch to ¾ inch	.062 inch	.031 inch
1 inch to 2 inches	.125 inch	.062 inch

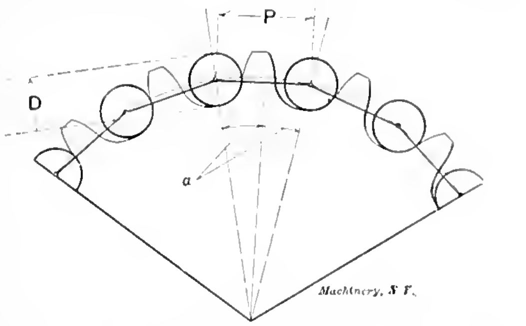


Fig. 4. For obtaining Pitch, Bottom and Outside Diameter of a Roller Chain Sprocket.

The tables of diameters on previous page have been prepared from these formulas.

Sprocket diameters should be very accurate, particularly the base diameter, which should not vary more than .002 inch from the value obtained from the tables. All sprockets should be gaged to discover thick teeth and inaccurate diameters. A poor chain may operate on a good sprocket, but a bad sprocket will ruin a good chain. Sprockets of twelve to sixty teeth give best results. Fewer may be used, but cause undue elongation in the chain, wear the sprockets and consume too much power. Eight-tooth sprockets ruin almost every roller chain applied to them, and ten and eleven teeth are fitted only for medium and slow speeds with other conditions unusually favorable.

Sprocket teeth seldom break from insufficient strength, but the tooth must be properly shaped. A chain will not run well unless the sprockets have sidewise clearance and teeth tapered at the ends. Fig. 5 is a practical shape.

Calling W the width of the chain,

$$A = \frac{W}{2}$$

$B = W$ − 1-64 inch when W = 1-4 inch or less.
$= W$ − 1-32 inch when W = 5-16 to 5-8 inch inclusive.
$= W$ − 1-16 inch when W = 3-4 inch or over.

Note that the curvature at the end of the tooth begins at the pitch line.

If the sprocket is flanged the chain must seat itself properly without the side bars coming into contact with the flange. The following values of C will be found safe:

Chain.	C not less than
1 in. P block, 1 in. P twin roller and ½ inch P block and ⅝ inch P roller	1-4 inch
1½ inch P block and ¾ inch P roller...	11-32 inch
1 inch P roller	1-2 inch
1¼ inch P roller	9-16 inch
1½ inch P roller	5-8 inch
1¾ inch P roller	13-16 inch
2 inch P roller	15-16 inch

The principal cause of trouble within the chain is elongation and this must, as far as possible, be eliminated. It is the result of stretch of material or natural wear of rivets and their bearings. To guard against the former, chain makers use special materials of high tensile strength, but a chain subjected to jars and jolts beyond the limit of elasticity of the material may be put in worse condition in an instant than in months of natural wear. If for any reason a link elongates unduly it should be replaced at once, as one elongated link will eventually ruin the entire chain. Such elongation frequently results from all the load being thrown on at once.

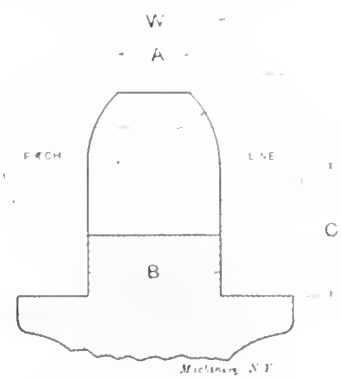


Fig. 5.

To minimize natural wear, chains should be well greased inside and out, protected from mud and heavy grit, cleaned often and replaced to run in the same direction and same side up. A new chain should never be applied to a much worn sprocket.

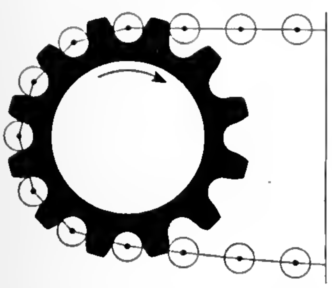


Fig. 6 A.

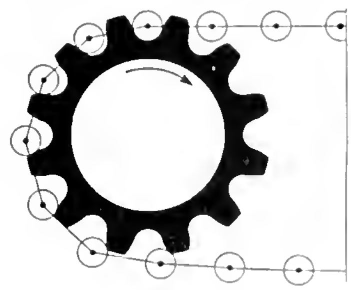


Fig. 6 B.

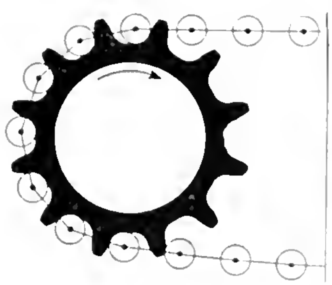


Fig. 7 A_1.

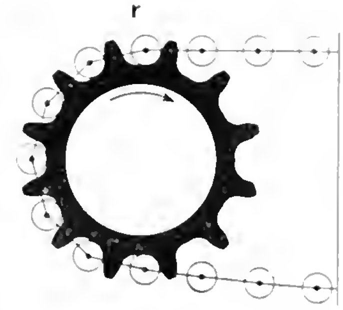


Fig. 7 B_1

The importance of pitch line clearances is clearly shown in Fig. 6, which represents a sprocket with no clearances.

The new chain, 6A, fits perfectly, but after natural wear, 6B the pitch of chain and sprocket become unlike. The chain is then elongated and climbs the teeth which act as wedges, producing enormous strain and disagreeable racket, and quickly wrecks itself.

Fig. 7 is the same chain on a driven sprocket, cut with clearances. When new, A_1, all rollers seat against their teeth. After long and useful life, B_1, the working roller, r, has shifted to the top, and the other rollers still seat with the same ease as when new. The chain may still be used until the stage indicated in B Fig. 6, is reached. B_1 also shows that the chain pull is taken by the one roller, r. Theoretically, all the rollers share the load in the case of A_1. This never occurs in practice, for infinitesimal wear within the chain causes *one, and only one*, roller, r, to bear perfectly seated against the working face of the sprocket tooth at any one time. In Fig. 8, A_1 shows the driver cut with clearance and with a new chain; B_1, the same chain after wear, which demonstrates that clearance alone on the driver will not provide for elongation. To operate properly the pitch of the driver must be lengthened.

which is done by increasing the pitch diameter by an amount dependent upon the clearance allowed.

In Fig. 9, A_3 is a new chain on a driver cut with clearance and increased pitch diameter. The working roller, r, is at the bottom of the sprocket. After the chain wears, B_3, the working roller, r, shifts to the top, and the chain is still good until the condition of B_2, Fig. 8, is reached.

This demonstration is quite true for a drive in which the chain pull is *always in the same direction*, and should be applied for such drives. The theoretical reasoning is intricate, so I shall refer those interested to "Roller Chain Gear," a treatise on English practice, by Hans Renold.

When the load reverses, and this is more frequently the case, each sprocket becomes alternately driver and driven. This happens in a motor car during positive and negative acceleration, or in ascending or descending a hill. In this event, the above construction is not applicable, for a driven sprocket of longer pitch than the chain will stretch it. No perfect method of equalizing the pitch of a roller chain and its sprockets under reversible load and at all periods of chain elongation has been found. This fault is eliminated in the "silent" type of chain; hence it runs smooth at a very much greater speed than roller chain will stand.

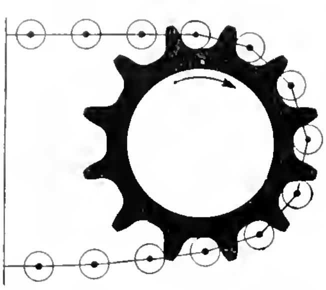


Fig. 8 A_2.

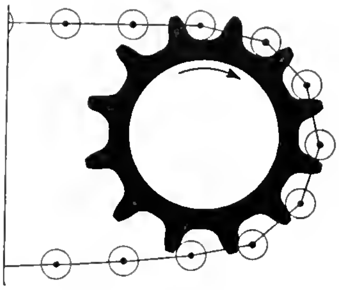


Fig. 8 B_2.

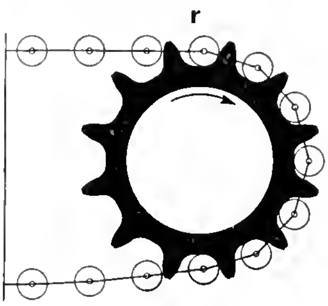


Fig. 9 A_3.

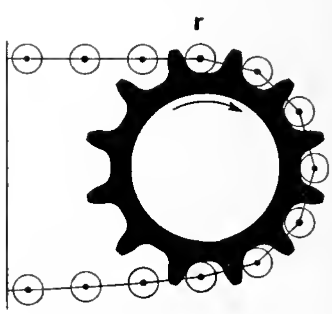


Fig. 9 B_3.

In practice there are comparatively few roller chain drives with chain pull always in the same direction, so manufacturers generally cut the driver sprockets for these with normal pitch diameter, same as the driven. Recent experiments have proven that the difficulties are greatly lessened by cutting both driver and driven with liberal pitch line clearance. Accordingly, chain makers now advise the following pitch line clearance (C in Fig. 10) for standard rollers:

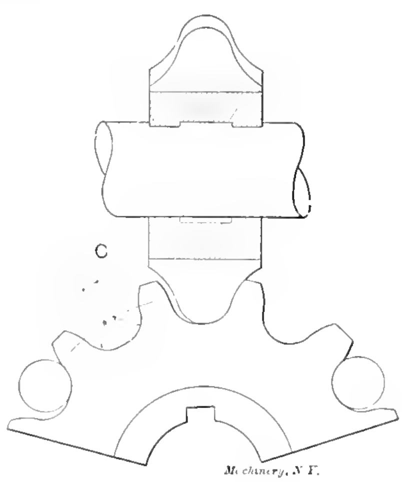


Fig. 10.

Pitch.	Clearance.
½ inch and ⅝ inch	1-32 inch
¾ inch	1-16 inch
1 inch	3-32 inch
1¼ inch	3-16 inch
1½ inch	7-32 inch
1¾ inch	1-8 inch
2 inch	5-32 inch

Cutters may now be obtained from B. & S. with this clearance, but their former cutters have only from .015 inch to .030 inch or none at all. To obtain the proper clearance with the older cutters, mill the sprocket, as usual, revolve it a sufficient amount to make the clearance conform with the above table, measuring on the pitch line (Fig. 10) and take an additional cut around. The base diameter should remain as figured from the pitch tables.

The above clearance table is figured for American and English standard size rollers, and will not apply to the Whitney standard. With this latter, it is not possible to obtain so much clearance on the 1, 1¼ and 1½-inch pitch without weakening the tooth beyond a safe limit.

There is yet much to be learned about roller chains and the pitch line clearances of their sprockets, but the hints herein given should enable chain users to obtain better results from their drives.

* * *

The use of nickel steel is becoming more and more extensive. In a report on the subject of steel hardening metals by Mr. Joseph H. Pratt, in the United States Geological Survey, it is stated that over 11,000 tons of nickel steel rails were manufactured in 1903. These rails were used on the Pennsylvania, Baltimore & Ohio, New York Central, Erie, Chesapeake & Ohio, and Bessemer & Lake Erie railroads. They are largely used on sharp curves where their value was first demonstrated by the Pennsylvania R. R. on the famous Horse Shoe Curve, near Altoona, Pa. From experiments made on this curve, it appears that nickel steel rails will outlast four ordinary steel rails. Nickel steel is also being extensively used where a non-rusting metal of high tensile strength is required. Nickel steel containing from 25 to 30 per cent nickel resists rust to a remarkable degree. It is being used in mines, for torpedo defense netting, umbrella wire, corset stays, condenser and boiler tubes, and many other purposes where steel is subjected to dampness. Not the least important feature of these nickel steel alloys containing a high percentage of nickel is the remarkable decrease in the coefficient of expansion. In fact with the alloy known as invar, the coefficient of expansion is nearly zero. By varying the proportions of nickel and steel the coefficient of expansion may be changed to agree with that of other metals, as for instance, platinum. Hence it is being substituted for platinum, which is very expensive, in the manufacture of incandescent lamps. Platinum happens to have practically the same coefficient of expansion as glass, which makes it possible to use it for the terminals which must pass through the glass. With other metals having a different coefficient of expansion the glass will crack, or the terminals will be loose, thus allowing leakage of air and destroying the high vacuum necessary to the success of the incandescent lamp.

* * *

A device known as the de Forest wireless ship localizer, the aim of which is to warn ships of their nearness to dangerous points, will be given experimental trial shortly on the Great Lakes. Ships so warned will have to carry wireless telegraph apparatus. For the tests on the lakes it is intended to install 52 automatic stations at the points of greatest danger to ships. These stations will operate continuously upon the approach of fogs or storms, and their effect will be felt for about six miles. Each will have its own characteristic call, so that an operator at a wireless instrument on shipboard hearing such a call will know that he is within six miles of the given locality. The intensity of the call increases as it is approached. The instrument on board ship for receiving the call is equipped with a long flat screen, pivotally mounted, in place of the antennæ wires usual in wireless telegraphy. By constantly turning the screen while the signals are being received, the direction from which the call comes may be indicated.

A REVIEW OF STEAM TURBINE PATENTS.—4.

Richard Schultz, 1900.

This invention, shown in Fig. 53, cannot be regarded other than as a modification of Pyle's turbine of 1895. Steam passes longitudinally through the wheel several times, as indicated in the engravings. *A* and *B* are two wheels attached to the shaft; *C* is an intermediate stationary disk with guide

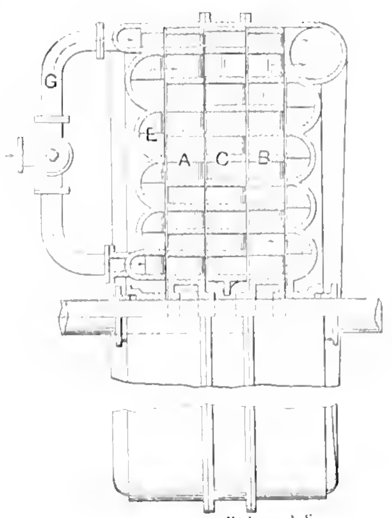


Fig. 53. Schultz Reversing Turbine.

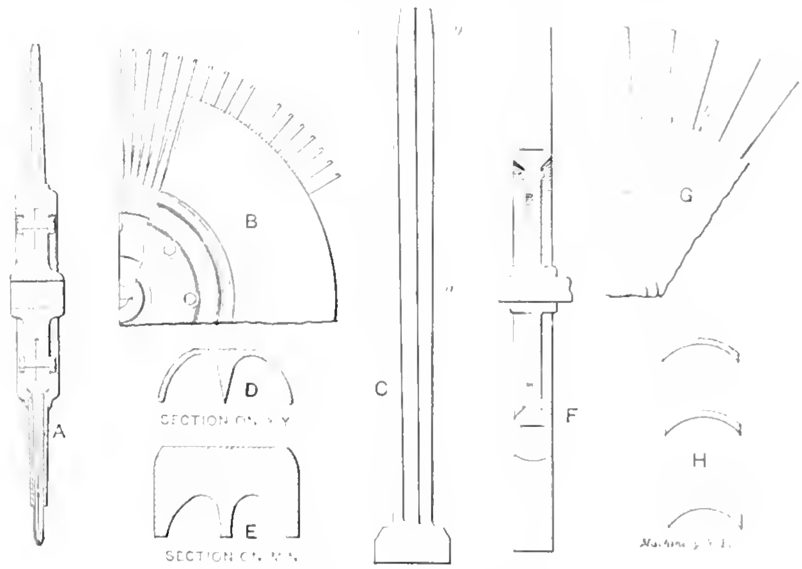


Fig. 54 Wheels Patented by Zoelly

passages, and *E* and *F* are stationary castings for reversing the direction of flow of the steam after it has passed through the passages of the wheels and guides, and directing it back through the next series of passages. In addition, he provides for a series of vanes for reversing the direction of motion against which steam flowing through the pipe at *G* impinges.

Zoelly, 1900.

The group in Fig. 54 shows certain features of construction for turbine wheels covered by two patents issued to Heinrich Zoelly, Zurich, Switzerland, one in 1900 and the other in

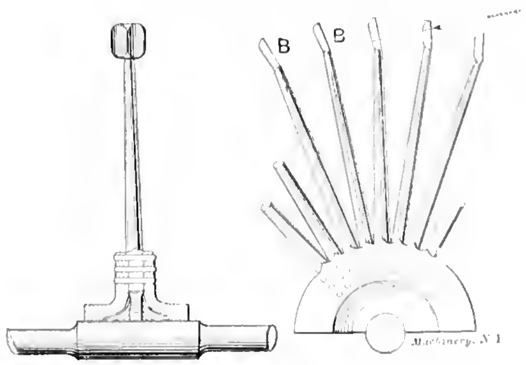


Fig. 55. Richards' Pelton-type Wheel.

1903. The inventions relate to wheels with radial arms, the outer ends of which serve as vanes for the wheel. These arms decrease in cross-section as they approach the periphery of the wheel and thus are proportioned to resist centrifugal force in such a way as to produce a uniform stress per square inch throughout their length.

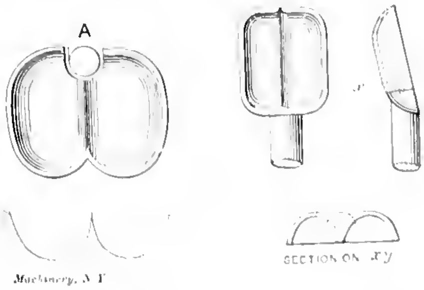


Fig. 56 Buckets proposed for Richards Wheel

The patent of 1900 is for a design of turbine blades suited to the Pelton type of wheel in which the stream is projected against the faces of blades which have a central rib to divide the stream and cause it to turn through nearly 180 degrees and discharge on each side of the wheel. The first claim of this patent is for "the combination in a turbine wheel of radial buckets separated from each other for a part of their length, each bucket having its receiving face channeled for the greater portion of its length, and a pair of flat disks inclosing said buckets from their inner ends for a greater portion of the length of the channeled part of the buckets." In Fig. 54, *A* and *B* are two sectional views of the wheel, *C*, an enlarged front view of one of the blades, and *D* and *E*, enlarged sections of the blade on the lines x y and m n respectively. At *F* and *G* are details of a wheel now used in the Zoelly turbine and already described in MACHINERY. In this type, the steam is directed against the blades on one side of the wheel and escapes on the other side. Sections of the blades are shown at *H*. The first claim is for a "turbine blade constructed with a gradually increasing longitudinal thickness and a longitudinal cavity of substantially uniform depth." Some of the other claims relate also to the method of clamping the blades in position, and the use of spacing blocks, *b b*, between them.

Richards, 1902.

The idea presented in the Zoelly patent of 1900 is carried a step further in a patent issued to J. Richards for a Pelton type of wheel, Fig. 55. The wheel consists of buckets, *B*, light in weight and drop forged on the ends of radial arms, which are attached to a central nave by pins inserted between the arms, as indicated in the illustration. The buckets are spaced

Fig 57 Buckets and Guides for Stumpf Turbine

further apart than is usual in turbines, because they are designed to be concave and reactive through a considerable angle of rotation, and thus will absorb the energy of the jet sufficiently throughout this range. The arms of the wheels are not covered by plates at the sides, as in the Zoelly design, the intention of the inventor being that the inside of the turbine casing shall be machined smooth, and the steam allowed to rotate with the wheel within the casing. The claim is in substance for a wheel having a single hub, of a diameter within the zone of disruptive centrifugal strain, with equidistant radial sockets formed therein; strong radial stems fastened in the sockets; and concave reactive buckets integrally formed on the extremities of the stems.

Stumpf, 1903.

The Pelton type of wheel devised by Prof Stumpf contains double U-buckets with a dividing ridge, milled out from the solid rim of the wheel and taking the form shown in the plan and sectional views of Fig. 57. He proposes to use a series of guide passages having the general contour of the dotted line shown at *A*, which gather up the steam after it has issued from the two sides of the wheel and return it in a single, solid stream at the center, where it impinges a second time against the blades of the same wheel. In Fig. 58 is shown a modified form of the guides having partitions extending in the direction in which the steam flows, for the purpose of insuring equal division of the steam jet over the whole breadth of the return buckets, with a view to preventing choking of the steam at the point where it strikes the wheel vanes.

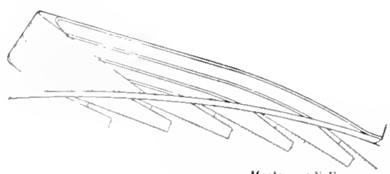


Fig 58 Modified Form of Guides for Stumpf Turbine.

It is pointed out by Prof. Stumpf that steam, in reversing its direction of flow in a turbine wheel, acquires sufficient centrifugal force to increase its pressure, frequently by a considerable amount, so that in leaving the vanes there is a sudden explosive expansion of the steam, causing a scattering of the jets. By catching the steam in the return buckets as it leaves the wheel, and bringing the streams together in a solid jet again at the center, he aims to overcome this action and to produce a more efficient type of compound turbine. His claims are broad ones, applying to the combination of admission nozzles, a turbine wheel with double buckets and double return buckets.

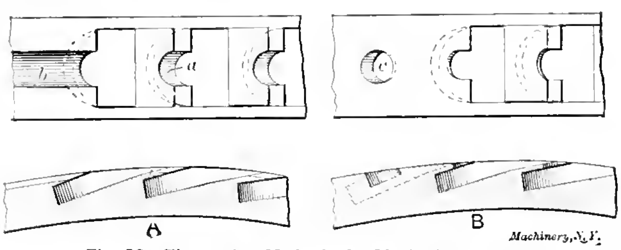


Fig. 59 Illustrating Methods for Machining Buckets.

In connection with the Stumpf patent, one issued in 1904 to Kaufhold and Hoffmann, and assigned to the manufacturers of the Stumpf turbine, relates to the process of cutting out the buckets. In order to insure a change in direction of the fluid of 180 degrees it is necessary that the grooved portion of the recess should complete a full half circle, and this is easiest accomplished by means of a disk milling cutter. In using such a cutter, however, it is necessary to cut out a circular portion of the rim, to allow room for the cutter arbor, as indicated at *a* in Fig. 59. One method of doing this is to use a stepped milling cutter, one part of which cuts the larger recess and the other part the smaller recess for the arbor. The methods covered by the patent, however, consist first in turning a groove, *b*, in the rim of the wheel before milling the recess, which obviously will accomplish the desired end. The other method is to drill holes in the rim, as shown at *c*. The inventors prefer either of these methods to the use of the stepped cutter method.

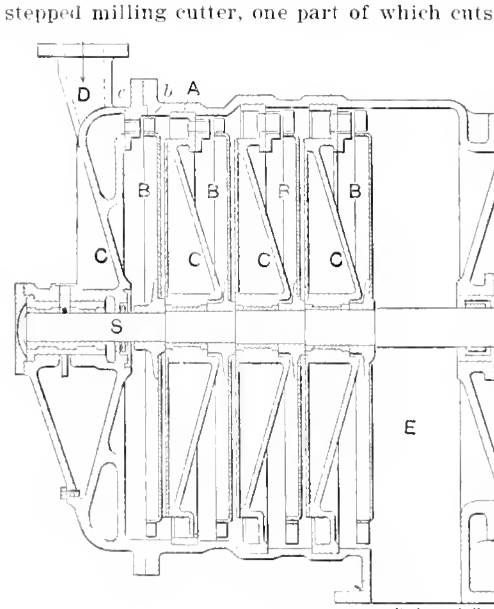


Fig. 60. Section of Rateau Turbine.

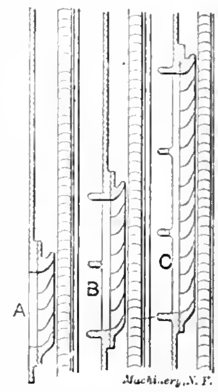


Fig. 61. Arrangement of Guides in Rateau Turbine.

Rateau and Sautter, 1903.

The Rateau turbine, the main principles of which are covered by this patent is, like the invention of Moorhouse, 1887, an impulse turbine consisting of a number of wheels upon which the steam acts in succession, each wheel being in a separate compartment. In Fig. 60, *A* is the turbine casing, *B B*, etc., are the rotating wheels attached to the shaft, *S*, and *C C C* are diaphragms forming the separate compartments. Steam enters through the intake pipe at *D*, passes between a series of guide vanes at *c*, where it is directed against the vanes, *b*, of the first wheel. It then passes through the guide vanes in the next diaphragm and impinges against the next wheel, and so on, until the exhaust space, *E*, is reached. The depth of the guide blades and wheel vanes increases progressively from the inlet to the outlet, to allow for the increasing volume of the steam.

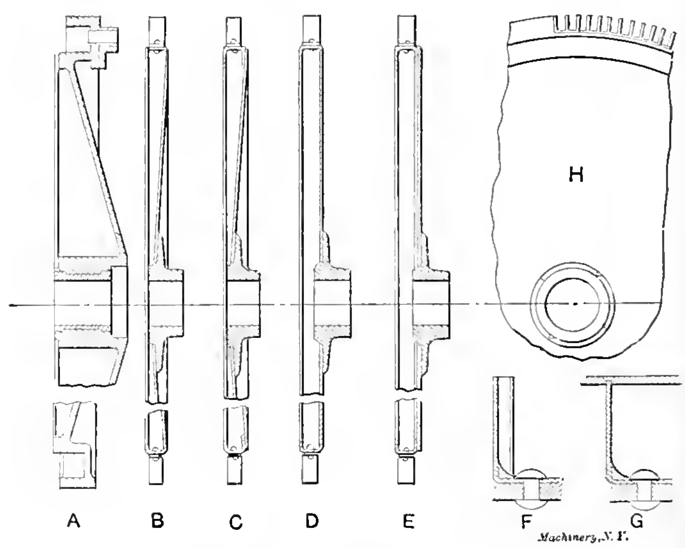


Fig. 62. Construction of Rateau Disks and Wheels.

The principle of this turbine as thus far outlined is in no way different from that of Moorhouse; but Rateau has introduced a principle in the arrangement of the vanes which is new and is covered by this patent. In Fig. 61 the first set of guide blades is shown at *A*. These are few in number and are arranged in, say, three groups about the periphery of the first disk. After passing through the wheel the next set of guide blades is reached at *B*, which consists of a greater number to accommodate the increasing volume of the steam, and these blades are arranged so as to extend by the first set in the direction in which the steam flows, as shown. When the steam reaches the first wheel it will be carried along a short distance by the rotation of the wheel before discharging into the wheel chamber, and a portion of the next set of guide blades should be located in advance of the previous set. At *C* the third set laps by still more, and finally a point will be reached where the blades will extend around the full periphery of the casing. The advantage of this arrangement over one in which steam is first admitted to the turbine around the whole periphery is that the steam at the admission point is comparatively small and the vanes would necessarily have but little radial depth at that point if they comprised a full circle, and there would be excessive friction of the steam when flowing through them. In the Rateau arrangement the steam passages are deeper and the volume of steam passing is large, in proportion to the rubbing surfaces of the vanes. The reference to this in the claims of the patent is as fol-

lows: "* * * distributors arranged in the membranes to direct the motive fluid directly upon the paddle blades, and said distributors increasing in width, and overlapping each other successively at one end and not at the other." Rateau also introduces features of construction on which claims are made, but which are in no way tied with the blade arrangement mentioned above. Some of these are shown in Fig. 62. At *A* is one of the diaphragms containing the guide vanes. At *B*, *C*, *D*, and *E* are typical wheels consisting of steel disks either flanged around their peripheries or else with annular channels riveted to their peripheries. In the first two instances, *B* and *C*, the disks are dished to add to their lateral strength and in the last two they are flat.

The vanes, which are curved suitably at the points where the steam strikes, are bent on an angle and riveted to the circumference of the disk. At *F* and *G* are enlarged details of the vanes, the second one showing a band or shroud riveted to the outer circumference.

Levin, 1904.

A type of wheel in which the steam is expanded completely in a nozzle before impinging against the buckets of the wheel and then is used several times in succession upon the blades of the same wheel. Steam is expanded in the nozzle, *N*, which projects it against one side of the semi-circular buckets, *B*, of the wheel. The steam passes around these buckets and is projected outward against the curved surface, *C*, of the casing twice in succession, which each time redirects the steam

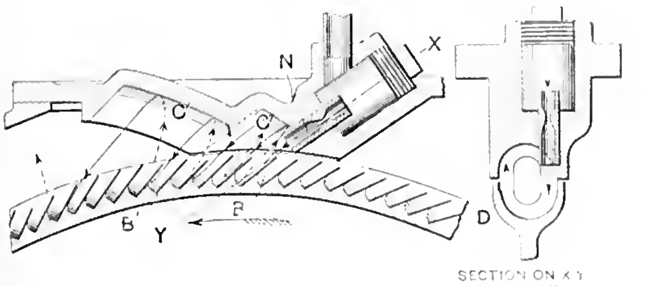


Fig. 63. Single-wheel Compound Turbine of Levin.

against the buckets of the wheel. The curved surface of the casing is stepped so that the portion at *C'* may be brought nearer to the wheel, and when the steam reaches the buckets located at *B'* it is returned against the surface at *C'*. As drawn, the arrangement is designed for a wheel having a peripheral speed of one-tenth the initial velocity of the steam since the steam is projected against the buckets five times in succession. The buckets are semi-circular in form.

At *D* in the right-hand sketch the sides of the buckets are cut away to allow the steam, which has become compressed in its impact against the wheel surfaces, to expand back to its original volume. The steam proceeds in a succession of helical whirls after leaving the nozzle, and it is necessary that the steam should be completely expanded in the nozzle so that it will be at constant pressure, but have a decreasing velocity after leaving the nozzle. The first claim for this wheel is for a "multiple impulse turbine, comprising a wheel having a row of buckets, an expansion nozzle delivering into said buckets, and a stationary reversing guide extending from said nozzle over a number of said buckets, to form a space open end to end within which the motive fluid proceeds in a helical whirl and is successively projected against the buckets of said wheel."

Hodgkinson, 1904.

It has been customary in the Parsons type of turbine to use by-pass valves to supply high-pressure steam to an intermediate point in the turbine where the pressure is normally lower than at the beginning, in order to temporarily increase the power of the turbine. The operation of the valves has usually been by hand, and the patent in question relates to an automatic valve for accomplishing the same end.

In Fig. 64, *A* is the steam inlet and *B* is a valve admitting high-pressure steam, when the valve is raised, to the space *C*, which connects with the intermediate part of the turbine. This is shown in Fig. 65, where steam enters at *A*; *B* is the valve, and *C* is the pipe leading to the turbine.

The valve, *B*, is hollow, allowing the steam to pass through it to the space, *D*, where it presses against the under side of the piston, *E*. *F* is a small passage leading from space *D* to the space, *H*, so that under ordinary conditions there will be balanced pressure on the piston, *E*, and the valve will be kept seated by the spring, *S*. Connecting with the space, *H*, in which the spring is located, is a pipe, *P*, leading to a by-pass

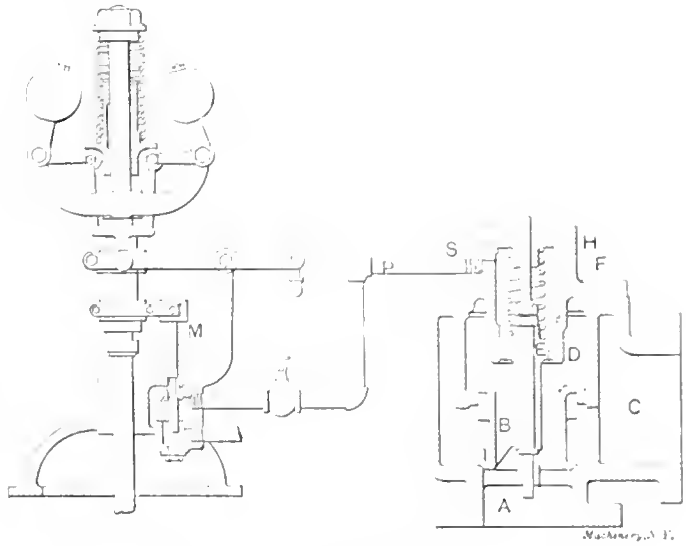


Fig. 64 Valve for Admitting High-pressure Steam to Low-pressure End of Turbine

in the base of the governor, shown at the left, which is opened or closed by a pilot valve, *M*, under control of the governor. Under normal conditions the pilot valve will be in the position shown, closing the by-pass and preventing the escape of steam from the chamber, *H*. Should the speed of the engine decrease beyond a fixed point, however, the governor balls would move inward, which would depress the governor yoke and the pilot valve, *M*, causing the by-pass to open and allow

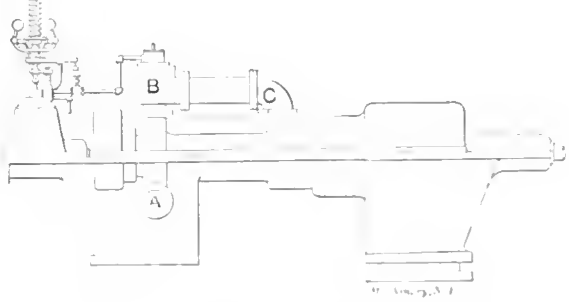


Fig. 65 Showing Connections for By-pass of Fig. 64

steam to escape from space, *H*, into the atmosphere or condenser. The result would be an unbalanced pressure on the piston, *E*, causing it to raise and compress the spring and open the valve, *B*, allowing the high-pressure steam to enter the low-pressure part of the turbine and increase the power

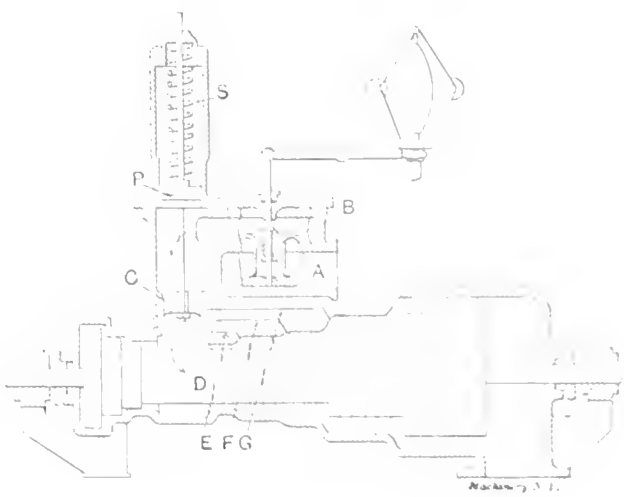


Fig. 66 Brown's Governing Arrangement

Brown, 1904.

Another patent for accomplishing the same result as with the Hodgkinson invention, in regulating the speed of a turbine by supplying high-pressure steam to the low-pressure passages under heavy loads, is that of C. E. L. Brown, of Brown, Boveri & Co., Switzerland. His invention consists in providing pipes from the steam chest to intermediate stages of the turbine and controlling the openings of these pipes by a valve operated by the governor.

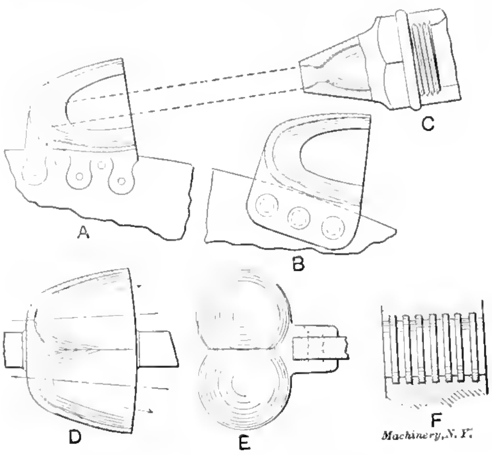


Fig. 67. Pelton Type of Buckets used by C. V. Kerr.

In Fig. 66, steam is admitted through the supply pipe, *A*, and when the throttle valve, *B*, is raised by the governor, steam will pass in the direction of the arrows through the valve, *C*, to the steam space, *D*, whence it will enter the high-pressure end of the turbine. The pipes, *E*, *F*, and *G*, leading to other points in the turbine, are opened to the steam space by movement of the valve, *C*, which uncovers the several ports in succession, when it is raised. Ordinarily, it is kept in its lowest position by the spring, *S*, thus closing all the ports. If, however, the speed of the turbine increases under a heavy load the governor will admit a greater quantity of steam through valve *D* to the steam space, increasing the pressure in the steam space and forcing the piston, *P*, upward against the pressure of the spring, by this means raising the valve, *C*, and admitting steam successively to the different stages of the turbine. Brown's patent also covers an arrangement, for a similar purpose, having the valve, *C*, controlled directly by the governor.

C. V. Kerr, 1904.

The compound impulse turbine, which is the subject of Mr. Kerr's patent, has buckets somewhat of the form of the Pelton water-wheel bucket. They are to be made of drop

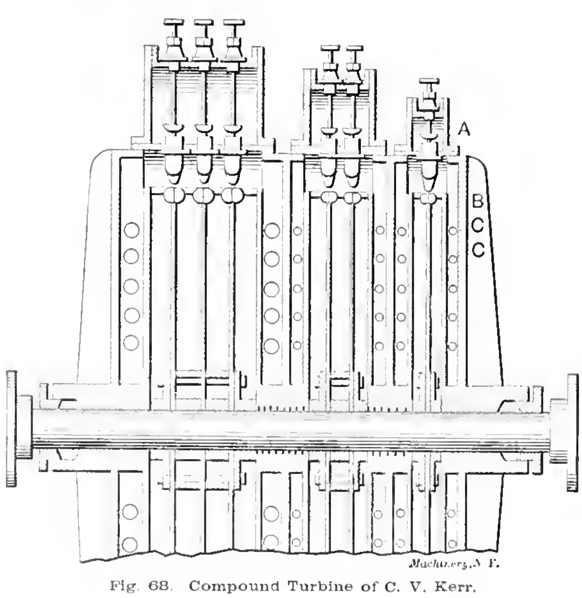


Fig. 68. Compound Turbine of C. V. Kerr.

forgings and of such a shape that they may be bored out perfectly smooth by means of a special reamer. Accordingly, each recess in the bucket on either side of the dividing wedge has a contour representing a surface of revolution. Sketches of the buckets appear in Fig. 67. The curves of the interior of the bucket in a transverse direction must obviously be circles in whole or in part, as shown at *E*, whereas the longitudinal section will show curves elliptical in shape.

The buckets are attached to steel disks, and in order to withstand the great strain he prefers to attach them, as shown at *A*, by dove-tailing and upsetting the interlocking parts, or else by electric welding. Another construction suggested is by riveting, as shown at *D*. Expansion nozzles are used, of the form indicated at *C*, Fig. 67, the tip of the nozzle being rather short inasmuch as the turbine is divided into stages and only a portion of the pressure of the steam has to be reduced at each stage. Each nozzle of the turbine is controlled by a hand valve.

In Fig. 68 is a partial longitudinal section of three stages, although ordinarily it would be constructed with six or more. As the steam progresses through the turbine an increasing nozzle area must be provided, and this the inventor prefers to accomplish partly by multiplying the number of disks in each space rather than by depending entirely on an increase of the areas of the individual nozzles. In the sketch *A* is one of the first series of nozzles, *B* is the first wheel, and *C C*, etc., are openings allowing the steam to pass from the first chamber to the next set of nozzles through a passage cored in the casing. The shaft is provided with a series of rings interlocking with a series of grooves in the partition between each chamber, as shown at *F* in Fig. 67. The object of these is to reduce leakage.

* * *

The U. S. consul at Birmingham, England, says that British industries are being rapidly rebuilt and reorganized on American lines. He complains that many British manufacturers or their representatives have visited America and, having been hospitably received by our manufacturers, have not hesitated to avail themselves of all possible information that would be helpful to them in putting their plants on a competing basis. He says that many young English graduates of the scientific classes of British universities and technical schools who are the sons of manufacturers, merchants, or professional men, are at work in American factories learning all they can about our methods. In this Consul Halstead sees a great national danger as in the movement he sees very little that is nationally reciprocal. Although American methods are condemned by the British technical press, and our products characterized as being "bad," "frail," "defective," "flimsy," etc., there are many Americans managing English factories and introducing the same systems which make American products formidable competitors in the marts of commerce. For instance, one American is now manager of a big British bridge company, and another is superintendent of the same works. With all the conservatism of the British manufacturers, it appears that some of them are outdoing American manufacturers in the matter of scrapping obsolete machines and of installing new and improved machinery in their stead. Hence the inference that the American manufacturer, who looks upon the markets of the world as his to exploit, must count upon an "Americanized" competition which hitherto has been unknown.

There is a whole lot of conceit and egotism in this view of foreign competition for American manufacturers who have no monopoly of new or original ideas, and it is wholly likely that British manufacturing concerns would have reorganized their plants without the stimulus of American ideas, if need be. It smacks somewhat of injustice to deny the right of foreign manufacturers to get new ideas wherever they can, for it is something that we have always done and are doing to-day. Industrial conditions change in all countries but more slowly in old than in newer sections, because of the inertia of investments. Perhaps one of the principal causes for our unexampled progress has been the absorption of foreign ideas unhampered by the fear of impairing the value of existing investments, which was and is now the case in older countries. We have taken whatever seemed good with no qualms as to its origin, but have not been imitators. If foreign concerns imitate us they will not be formidable—if they imitate and originate they will.

THE DESIGNING AND MAKING OF BELLS.

F. P. LOTZ.

F. P. Lotz.

The production of church bells is an art of uncommon interest. Few people understand it at all, and hence it excites the liveliest interest when attention is drawn to it even in an indirect way. How closely bells are united to the human feelings, the begrimed workmen who make them hardly appreciate. We laugh with their merry wedding peals, weep with their somber funeral toll, and, if we are night workers in a great city, we roundly abuse them when their clanging disturbs our Sunday morning slumbers. Everybody that has ears and is not deaf has been enthused and alarmed, has laughed or cried at the sound of the bells, but few persons have any idea of how they are manufactured.

Sometimes they are called brass bells and occasionally bronze bells, but strictly speaking, neither term is correct. Brass is a combination of various metals such as copper, tin, lead, and zinc; bronze, much used in art statuary, is composed of the same metals, but not in the same proportions. Bell metal is entirely different in composition for it consists of only two metals, namely, pure copper and pure tin Any addition of another kind of metal is an adulteration and always has an injurious tendency. The best tone effect in bell metal is, strangely enough, confined within very narrow limits, for any so-called bell metal having more than seventy-eight parts copper to twenty-two parts tin is too soft to produce the best quality of tone, while that having more tin than twenty-three parts in the 100 is too brittle and hence not safe. The old German bell founders used to make their bells of eighty parts copper to twenty parts tin, and bells are still made of that composition, but they lack brilliancy or "tone color."

The primary art of bell casting is in "drawing it" accurately as to shape so as to secure the best acoustic proportions. I believe each founder has his own rules for this work,

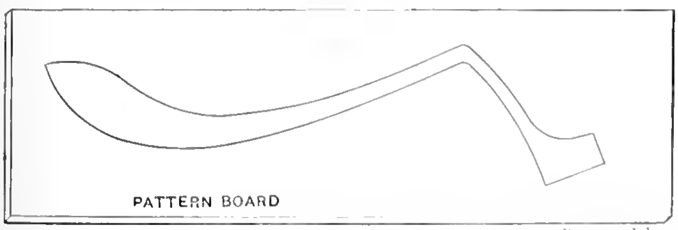


Fig. 1. Drawing of one-half of Bell.

but as they are in a large measure trade secrets, it is hardly expedient for me to discuss them here. The first step in making a bell sweep is to draw the pattern and for this purpose a good straight-grain white pine board of sufficient length and width is chosen and dressed down to about three-eighths of an inch in thickness. When the bell is drawn on this board it looks like Fig. 1. The rule for securing the peculiar empirical shape of the bell is in some respects quite complex, and there are different ways of obtaining the desired curves, since each founder has his own formula according to his own notion of accuracy. For the sake of convenience I will give an example of a process used in England a half century or more ago, for, of course, no one expects me to tell exactly my process for drawing the shape of the bell which I prefer, though I have my preference, of course, with reference to shape and acoustic properties involved. We must first determine upon the size of the bell, which must be mathematically calculated with reference to the note required, but I will not discuss this question because it involves technicalities which I do not think will much interest anyone outside the trade. We begin by drawing a horizontal line *SI*, representing the diameter (see diagram, Fig. 2), and a perpendicular line, *C*, representing the center of the bell, and we then lay off the outside diameter of the half section by drawing the perpendicular line, *OD*. Using the proportions of the drawing rule or formula, we now proceed to stick pins on the line *OD*, as shown by the figures 1, 1, and 3, and stretch a strong thread from the two pins 1 and 1 around the pin 3; when this is done and the string firmly tightened (see *AA*), pin 3 is withdrawn and a pencil is set at that point held firmly in a perpendicular position keeping the string taut. Carrying the pencil down as indicated by the dotted line, *aa*, it will form the quarter of an ellipse shown by the heavy dotted line, *AA*, which is the inner shape or curvature of the bell. To make the outside curvature or shape, the same process is followed shown by the lines *BB*, and in stretching the string with the pencil, as per the partly dotted line, *bb*, the outside curve, shown by the heavy black line ending at *K* is formed. This leaves only the outside curve of the sound-bow to be drawn, and this is done by following another part of the formula and forming the section of a circle, *HG*, by means of a compass. There now remains a small space, *W*, to be closed up, which is done by hand, in accordance with any convenient process, for the section is so small that no particular rule is necessary.

The crown or top of the bell, indicated by *Z* and *Y*, is then drawn according to any formula. The crown top *T*, has nothing to do with tone, but may be of any shape or device which

Fig. 2. Method for Laying out a Bell.

pleases the founder as long as it secures a good safe method of hanging and swinging the bell. Safety is the first consideration, and it is obvious that a bell suspended by only one bolt, no matter what the thickness of the bolt, is not entirely safe. In all continental and English bells there are numerous bolts, and none of the European founders think of hanging the bell on one bolt only I have often read of bells attached

F. P. Lotz was born in Baltimore, Md., in 1859. He took a course in business college and a correspondence course in literature, and his education outside of this was acquired by persistent study at home. He has been in the employ of the Henry McShane Mfg. Co., Baltimore, Md., the E. W. Van Duzen Co., Cincinnati, O., and Meneely & Co., West Troy, with whom he is at present. Mr. Lotz has contributed quite extensively to encyclopedias and to various New York, Boston and Cincinnati publications.

to the swinging yoke by but one bolt, which suddenly parted, and the bell dropped, making sad havoc in the tower. For this reason, if for no other, churches should select a bell held securely by two or more bolts.

The bell drawing or section is now complete, and the next step is to cut it out and make the two sweep patterns correspond with the inside and the outside shape respectively. This rule or process will make the bell at Y one-third of the thickness at X, which is the "soundbow" or thickest part of the bell, and is the point where the clapper strikes. The sweep

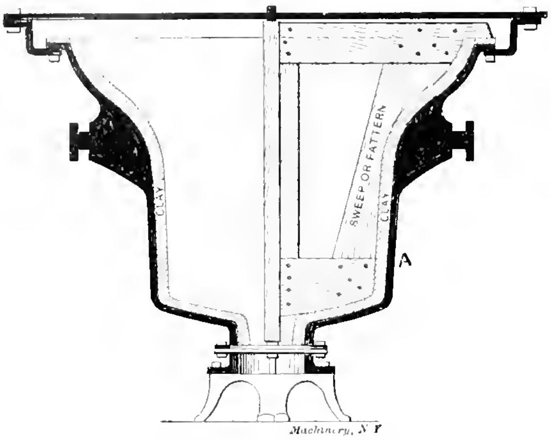


Fig. 3. Bell Sweep and Mold.

board or drawing which represents the outside shape of the bell will have little projections, which the founders call "beads"; these make little grooves in the molds and form the adorning lines on the surface of the bell, relieving what would otherwise be an unbroken smooth surface. These lines are seen in Fig. 4, which shows a finished bell. Fig. 3 shows a sectional view of a bell mold with the sweep or pattern inserted in working shape. The outer section, A, is an iron flask liberally perforated so as to give vent to the gas which is generated while pouring or casting the bell. This gas ignites and burns away, thus relieving internal pressure and obviating an otherwise possible explosion. Over the surface of the flask a layer of wet loam of equal and suitable thick-

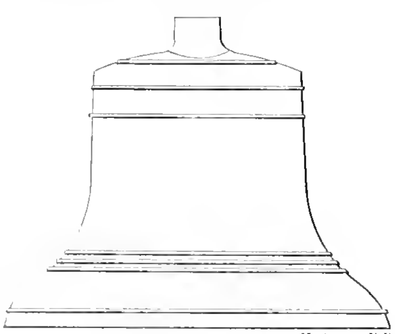


Fig. 4. Finished Bell.

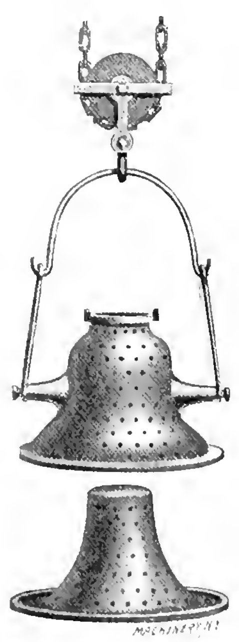


Fig. 5. Iron Flask consisting of "Case" and "Core."

ness is coated and baked, then another layer is coated on and baked, and so on, layer after layer, until the proper shape is secured. There are two such iron molding cases or flasks fitting one over the other, as shown in Fig. 5. The under one has its loam coating on the outer side, which has the inner shape of the proposed bell, while the upper iron molding flask has the loam on the inner surface, and forms the outside shape of the bell which is let down over the under mold and carefully adjusted all around, leaving a space inside between the two molds. The under flask is called the core, the upper or outer one the case; the space between these is filled up by the molten bell metal which, when cooled, is the bell. When the bell is taken out of the molds, it is polished and the hangings—tongue or clapper, etc.—fitted to it. It then receives several ringing tests to ascertain its tone and resonant quality and to observe its mechanical excellence and adjustment, after which, if it appears to be good in all points, the bell is shipped to the purchaser. The making and shipping of a bell usually require from ten to fifteen days in the smaller sizes, but the larger sizes—of 1,500 pounds and heavier—require more time. A peal of bells takes from forty to ninety days' time, while to make a chime of nine or more bells, from three to six months' time must be allowed.

* * *

NOTES ON LUTES AND CEMENTS.*

Luting and cementing materials for various purposes in the laboratory and shops may be classified as follows:

1. Water- and steam-proof.
2. Oil-proof.
3. Acid-proof.
4. Proof to hydrocarbon gases
5. Chlorine-proof.
6. Elastic.
7. General purposes.
8. Marine glue.
9. Gaskets.
10. Machinists'.
11. Leather (belting).
12. Crucible, iron, and stone
13. Core compounds.
14. Briquetting.

1. *Water-Proof Compositions.*—Of use to engineers are the asphalt fluid coatings for reservoir walls, concrete foundations, brick, wood, etc. Asphalt only partly dissolves in petroleum naphtha, but heated in a steam-jacketed kettle and not thinned out too much, a mixture of the two may be obtained in which the part of the asphalt not dissolved is held in suspension. Asphalt is entirely soluble in benzol or toluol, which are about the cheapest solvents for all the constituents of asphalt. Tar and pitch are sometimes used in this connection, but tar contains water, light oils, and free carbon, and does not wear as well as good refined asphalt; and pitch contains free carbon, which is sometimes objectionable when thinned out with a solvent. The asphalt alone is somewhat pervious to water, and this is improved by adding about one-fourth its weight of paraffin, and made better if in addition a little boiled linseed oil is added also. For thicker compositions, where body is required, asbestos, stone powder, cement, etc., may be added as fillers. Lutes of linseed oil thickened with clay, asbestos, red or white lead, etc., are water-proof if made thick enough. These are much used for steam joints. Flaxseed meal made into a paste with water is often serviceable, the oil contained serving as a binder as the water evaporates.

2. *Oil-Proof.*—The most useful lute for small leaks, etc., is the well-known "hektograph composition," as follows:

Good glue or gelatin	2 parts
Glycerin	1 part
Water	7 parts

This is applied warm and stiffens quickly on cooling. Another very useful composition is a stiff paste of molasses and flour. Another preparation, impervious to oil vapors, is the "flaxseed poultice," mentioned in Section 1, which is proof to oil vapors. One of the strongest cements, and one which is really oil-proof, water-proof, acid-proof, and proof to almost everything, is a stiff paste of glycerin and litharge. These form a chemical combination and set in a few minutes. If a little water is added, it sets more slowly, which is often an advantage. It is mixed when required for use. Plaster-of-paris wetted, by itself, or mixed with asbestos, straw, hair, etc., is useful. A solution of silicate of soda made into a stiff paste with carbonate of lime, gets hard in six to eight hours.

3. *Acid-Proof.*—The asphalt compositions already mentioned, compositions of melted sulphur with fillers of stone powder, cement, sand, etc.; also the following, which withstands hydrochloric acid vapors:

Rosin	1 part
Sulphur	1 part
Fire clay	2 parts

The lute composed of boiled linseed oil and fire-clay acts well with most acid vapors. The composition of glycerin and litharge referred to is useful in this connection, especially when made up according to the following formula:

Litharge	80 pounds
Red lead	8 pounds
"Flock" asbestos	10 pounds

fed into a mixer, a little at a time, with small quantities of

* Abstract of paper presented by Mr. S. S. Sadtler before the Engineers' Club, June 4, 1904.

boiled oil (about six quarts of oil being used). Sockets joined in 3-inch pipes carrying nitric acid were calked with this and showed no leaks in nine months. A particularly useful cement for withstanding acid vapors, being also tough and elastic, is:

Crude rubber, cut fine	1 part
Linseed oil, boiled	4 parts
Fire-clay	6 parts

The rubber is dissolved in carbon disulphide to the consistency of molasses and then mixed with the oil. Other examples of acid-proof cements, taken from "A Handbook of Chemical Engineering," by George E. Davis, and vouched for by the author, who has used them in chemical engineering work, are as follows:

"Black putty," made by intimately mixing equal portions of china-clay, gas-tar, and linseed oil. The china-clay must be well dried by putting over a boiler, etc. Barytes cement is composed of pure, finely ground sulphate of barium, and is made into a putty with a solution of silicate of soda. This sets very hard when moderately heated, and is then proof against acids. The gravity of the silicate of soda should be between 1.2 and 1.4, 24 deg. to 42 deg. Beaumé. If too thin, it does not hold; and when thicker than 1.4, it expands and breaks.

4. *Hydrocarbon gases.*—Compositions of plaster and cement, the former setting more quickly, are used. Also compositions of casein, such as:

Finely powdered casein	2 parts
Fresh slaked lime	50 parts
Fine sand	50 parts

Water is added, when used, to form a thick mush. Various mixtures of silicate of soda are employed in which the thick silicate is absorbed in some inert material, as clay, sand or asbestos.

5. *Chlorine.*—The best and only reliable compositions are a few made with Portland cement, and the following is much used for electrolytic and chemical plants:

Powdered glass	1 part
Portland cement	1 part
Silicate of soda	1 part

A small amount of powdered slate.

This lute is said to stand acid and alkali, as well as the influences of chlorine. Linseed oil made into a paste with fire-clay serves for a time.

6. *Elastic Cements.*—The various cements containing rubber are elastic, if it is in predominating amount; many containing boiled linseed oil and the hektograph composition already mentioned are quite elastic. The rubber-linseed oil cement, given under Section 3, is very tough and useful for nearly all purposes except when oil vapors are to be confined. The most useful single rubber lute is probably the so-called Hart's india-rubber cement. Equal parts of raw linseed oil and pure masticated rubber are digested together by heating and this mixture made into a stiff putty with fine "paper stock" asbestos. It is more convenient, however, to dissolve the rubber, first in carbon disulphide, and after mixing the oil with it, to let the solvent evaporate spontaneously.

7. *General Purposes.*—One of the most useful is plaster-of-paris, and especially when mixed with asbestos, straw, flush trimmings, hair, broken stone, etc., used according to temperature, strain, and other conditions. A putty of flour and molasses is a good composition to keep in a works ready for quick application when needed. It serves almost any purpose at moderate temperatures for a time. Casein compositions have great strength. White of egg made into a paste with slaked lime is strong and efficient, but must be used promptly on account of its quick setting qualities.

8. *Marine Glue.*—This can be purchased almost as cheaply as made. The rubber must first be dissolved in carbon disulphide or turpentine before mixing with the heated combination of the other two ingredients. Its uses are well known.

Crude rubber	1 part
Shellac	2 parts
Pitch	3 parts

9. *Gasket Compositions.*—Of course, almost any cementing substance may be used with rings of asbestos, etc., for gaskets, but some are specially adapted to the purpose. With regard to asphalt, tar, pitch and petroleum residuum, soft or hard pitch is recommended, as may be desired, because there are no light oils or water to go off at low heats, and the free carbon and compounds very high in carbon are good fillers to asbestos gaskets at high temperatures. Silicate of soda by itself is much used, but is sometimes advantageously mixed with casein, fine sand, clay, asbestos, carbonate of lime, caustic lime, magnesia, oxides of heavy metals, such as lead zinc, and iron, and powdered barytes. A few that might be selected are—silicate of soda and asbestos; silicate of soda asbestos and slaked lime; silicate of soda and fine sand; silicate of soda and fire-clay.

10. *Machinists' Cements.*—These are the well-known red and white leads. The red lead is often diluted with an equal bulk of silica or other inert substance so as to make it less powdery. The best way to do this, however, is to add rubber or gutta-percha to the oil as follows:

Linseed oil	6 parts by weight
Rubber or gutta-percha	1 part by weight

The rubber or gutta-percha is dissolved in sufficient carbon disulphide to give it the consistency of molasses, mixed with the oil, and left exposed to the air for about twenty-four hours. The red lead is then mixed to a putty. Oxide of iron makes a less brittle cement than red lead. Probably fish oils and red lead would make good lutes of the class for joining pipes, as the fish oils are not such strong drying oils as linseed and their use might be a case of permissible substitution rather than adulteration.

11. *Leather Cements.*—1. Equal parts of good hide glue and American isinglass, softened in water for ten hours and then boiled with pure tannin until the whole mass is sticky. The surface of the joint should be roughened and the cement applied hot. 2. One pound of finely shredded gutta-percha digested over a water-bath with 10 pounds of benzol, until dissolved, and 12 pounds of linseed oil varnish stirred in. 3. Seven and one-half pounds of finely shredded india-rubber are completely dissolved in 10 pounds of carbon disulphide by treating while hot, 1 pound of shellac and 1 pound of turpentine are added, and the hot solution heated until the two latter ingredients are also dissolved. Another leather cement is as follows:

Gutta percha	8 ounces
Pitch	1 ounce
Shellac	1 ounce
Sweet oil	1 ounce

These are melted together.

Still another is as follows: Fish glue is soaked in water twenty-four hours, allowed to drain for a like period, boiled well and a previously melted mixture of 2 ounces of rosin and ½ ounce of boiled oil is added to every 2 pounds of glue solution.

12. *Iron and stone cements.*—When iron in a fine state of divisions, as in fresh filings or cast-iron borings that have been powdered, is mixed with an oxidizing agent, such as manganese dioxide or a substance electro-negative to iron such as sulphur, in a good conducting solution like salt or sal-ammoniac galvanic action sets in very rapidly, and the iron swells, by forming iron oxide, and cements the mass together. It is best diluted with Portland cement:

Iron filings	10 parts
Manganese dioxide, or flowers of sulp'r	10 parts
Sal-ammoniac	1 part
Portland cement	20 to 40 parts
Water to form a paste.	

A hard stone-like composition is made as follows:

Zinc oxide	2 parts
Zinc chloride	1 part
Water to make a paste	

Magnesium oxide and chloride may also be used in like proportions. When used in considerable quantity this cement is mixed with powdered stone, for economical reasons, the proportions depending upon the character of the work

* * *

In the new *Times* building there will be few brass railings, signs, etc., requiring polishing. The management estimates that the labor wasted on one brass railing in the old *Times* building would have paid for it in solid silver.

TO MEASURE THE RADII OF DEEP-HOLE DRILLS.

OTTO ECKELT.

Deep-hole drills of the type shown in Fig. 4 should be made so that the cutting edge or lip *a* of the drill shall be a radial

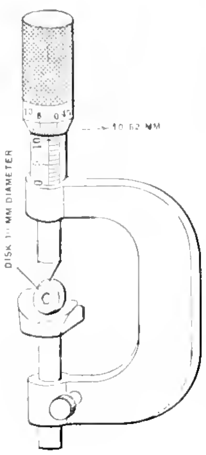


Fig. 1.

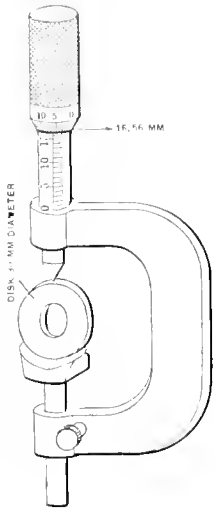


Fig. 2.

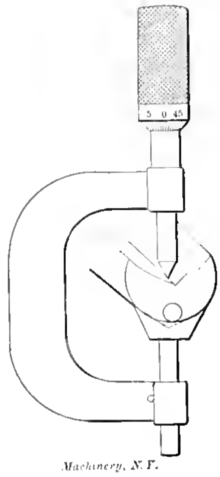


Fig. 3.

line, or in other words, shall go exactly through the center of the drill. It is clear that if a drill is made whose cutting edge lies under the center, a small core of the stock in the center

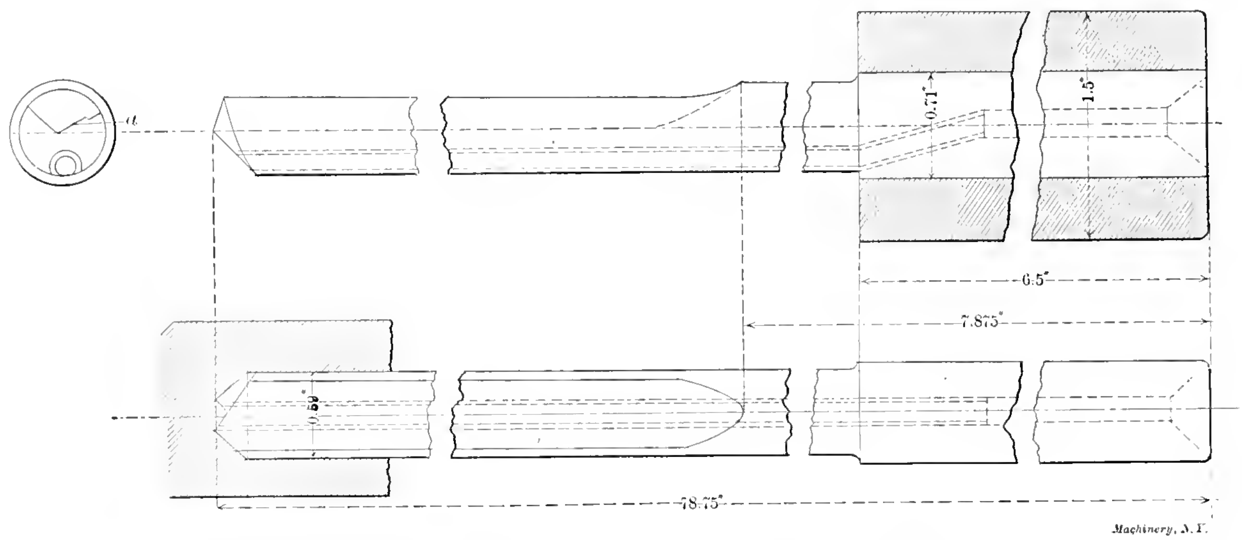


Fig. 4. Deep-hole Drill of the Type to which the Micrometer and its use Applies.

will not be cut off, and will instead tend to remain and form a slender column or thread remaining in the hole. On the other hand if the cutting edge lies over the center, the center portion cannot be cut out, but will be crushed together, the same as occurs with an ordinary twist drill. In deep-hole drilling this will not do as it will very soon cause inaccuracy of the hole or breaking of the drill. Hence it follows that the location of the center exactly in the cutting edge is very important. A glance at a cross section of the drill, Fig. 4, convinces us that a direct measuring of the drill center cannot be made with ordinary instruments. Hence Ludwig Loewe & Co., of Berlin, employ for this purpose a special micrometer with disks and V-shaped anvil block, the principle and use of which is described in the following:

Fig. 1 shows the special micrometer, which measures the radii of deep-hole drills up to 60 mm. (2.338 inches). Its construction is the same as that of an ordinary micrometer with a V-point for measuring screw threads, but in addition it has an adjustable V-block which is locked in position by a clamping screw; also two disks 10 and 30 mm. in diameter are provided. The smaller disk is used for setting the micrometer for drills up to 32 mm., as shown in Fig. 1, and the larger one for drills of 30 to 60 mm. diameter. For measuring drills of small diameter up to 32 mm. the scale of the micrometer is set to 10.52 mm. ($5 + 5 \times 1.1045$) and the disk of 10 mm. diameter is placed in the V-block, which latter is pushed against the measuring point and clamped fast in this position, whereupon the preliminary adjustment necessary is completed. For adjusting the micrometer for drills of 30 to 60 mm. diameter, the 30 mm. disk is used in the same manner, but the scale of the micrometer in this case is adjusted to 16.56 mm. (15×1.1045). After having found the preliminary adjustment of the V-block for drills up to 32 mm. diameter, as shown in Fig. 1, the radius or half the diameter of the drill to be measured is multiplied by the constant 1.1045, and the scale of the micrometer adjusted accordingly; or for greater convenience we may use the diagram, Fig. 9, in which we can read off the product of $r \times 1.1045$ without calculation. For example, suppose we wish to measure a drill whose radius is 7.45 mm. We must find the proper reading for the micrometer screw when the drill is laid in the angle block and the point adjusted, as indicated in Fig. 3. Turning to the diagram, Fig. 9, we find in the upper horizontal scale the figure corresponding to 7.45 and trace downward along the vertical line until we reach the diagonal, thence going horizontally from this point toward the right or left, whichever may be convenient, we find in the vertical scale the number 8.2 mm., or the product of 7.45×1.1045. Hence, if in measuring the drill of 7.45 mm. radius, we get a micrometer reading of 8.2 mm., it is known that the angle of the groove lies exactly in the center of the drill.

To adjust the micrometer for drills from 30 to 60 mm. diameter, the radius of the drill is multiplied by the constant 1.1045 and 15 mm. is subtracted from the product, or $r \times 1.1045 - 15$ mm. = micrometer setting. The diagram, Fig. 10, however, saves this calculation and is used in the same manner as Fig. 9. For example, to find the micrometer setting for a drill having a radius of 27.35 mm.: In the proper hori-

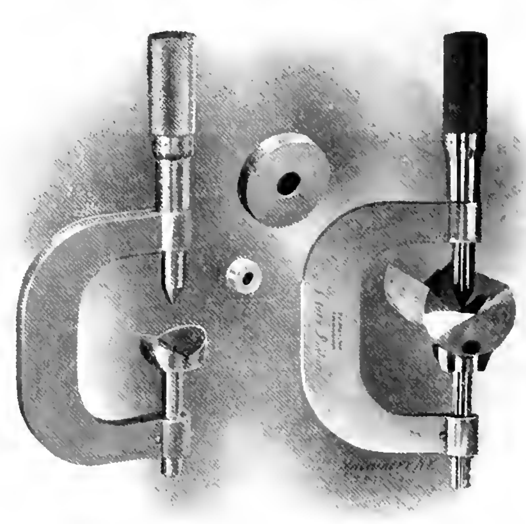


Fig. 5. Fig. 6.

zontal scale we find the point corresponding to 27.35 and follow the vertical line downward until it intersects the diagonal, thence to the right or left to the vertical where we read 15.2. With this datum any excess or deficiency of thickness

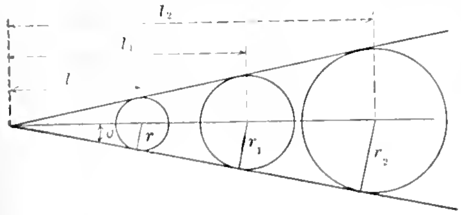


Fig. 7.

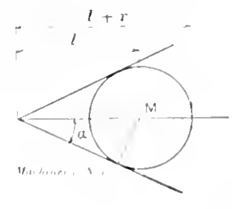


Fig. 8

of the drill over the center can be read off directly from the scale. Figs. 5 and 6 are from photographs showing substantially the same as Figs. 1, 2, and 3.

Principle of the Gage.

The principle of the gage depends upon the proposition that the homologous sides of similar triangles are in direct proportion. Hence in Fig. 7 we have $\frac{r}{l} = \frac{r_1}{l_1} = \frac{r_2}{l_2}$, etc. Therefore the values of l_1 and l_2 are easy to determine, since $l = \frac{r}{\sin \alpha}$

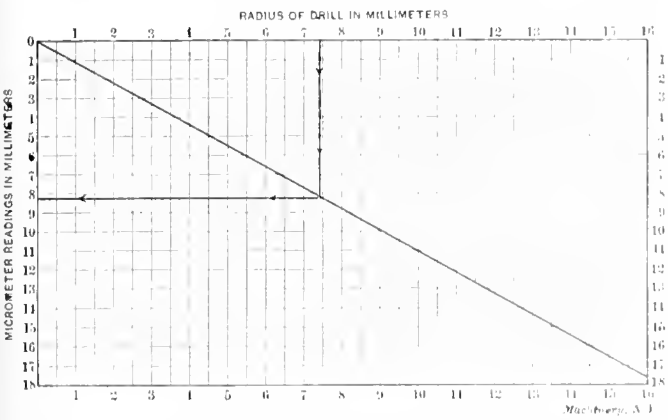


Fig. 9 About one-fourth size of Original.

in which r corresponds to the radius of the drill, and $\alpha = \frac{1}{2}$ the constant angle of the V-block of the micrometer, whence we derive the constant 1.1045.*

It will be observed that the product of the radius by the constant is used directly when setting for drills 32 mm. or less diameter, but that when measuring drills of 30 to 60 mm. the product is diminished by 15 mm. This comes about because in setting to the 30 mm. disk the micrometer screw is adjusted to 16.56 mm (instead of 31.56 mm.) in order to make the

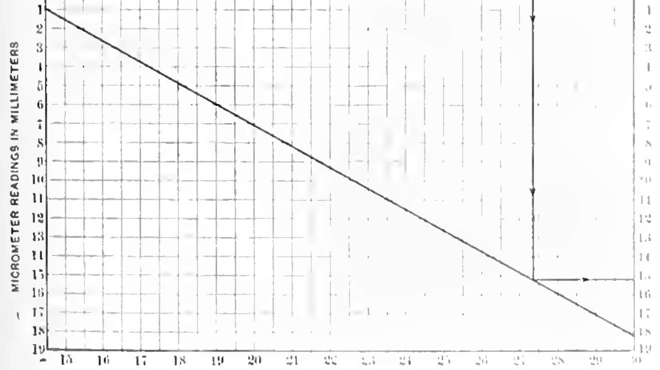


Fig. 10. About one-fourth size of Original

scope of the micrometer include the larger drills without the need of making a larger frame bow. The principle is illustrated in Fig. 8. For the disk M we reckon $l + r = \frac{r}{\sin \alpha} + r$.

* From the direction to use the constant 1.1045 it would appear that the included angle of the V-block must be 129 deg. 46 min.; the constant stamped on the frame of the micrometer shown in Figs. 5 and 6 is 1.103, but both give an odd figure for the included angle, the latter making it 129 deg. 50 min. In view of the fact that an odd angle was chosen it would have seemed more in the interest of convenience to have made it one that would have given a simpler constant. For instance angle 130 deg. 46 min. would give a constant almost exactly 1.1. —EDITOR.

Hence if one sets the screw of the micrometer to this measure and pushes the V-block with the disk M resting in it, until the disk is found to be in perceptible contact with the measuring point of the screw and there clamps it fast, the gage is adjusted. The proof of the correctness of the setting is that if we put back the micrometer screw equal to $l + r$ then will the point of the screw lie in the vertex of the angle α. In other words the lengths l, l_1 and l_2 should be exactly indicated without calculation.

* * *

GETTING THE FULL VALUE OUT OF JIGS.

J. F. MIRRIELEES

At the beginning of this article the writer finds it necessary to make three assumptions: First: That every shop manager recognizes the indispensability of jigs where rapid production at the lowest possible cost, and duplicate workmanship are the aims. Second: That his equipment of jigs be more or less complete. Third: That his jigs be in a somewhat satisfactory working condition.

Throughout this article the word "jig" will be meant to include all jigs, templets, fixtures, appliances, etc., which aid in the rapid and accurate machining of parts. With such assumptions allowed, the necessity for some systematic scheme of management for the use and care of the jigs should be apparent. However, it is not uncommon, even in these days, when the jig is admittedly one of the main factors instrumental in developing the shops of the past (where machinery was "built)," into the shops of the present (where it is "manufactured)," to find concerns where the jigs are given no consideration beyond designing them and keeping them in a questionable state of repair.

The whole tool or jig scheme is so interwoven with the entire shop that the success of a system cannot be dependent entirely upon any one person but upon the co-operation of all.

The tool foreman is the one, after the management, who contributes most to either success or failure, and therefore his selection should be made with care. This tool foreman, as we prefer to call him, is to the modern shop what the head toolmaker was to the old-time shop, and his increased duties and responsibilities entitle him to the new title. He should possess executive as well as mechanical ability, and be broad-minded and up-to-date, for to him should be intrusted the tooling of the machines, the manufacture and care of the jigs, the complete control of the tool room and the enforcement of any system the management may inaugurate. He will, however, be doomed to only partial success, if not absolute failure, without the support of some working system; and that is what this article proposes to outline.

The first thing we find it necessary to provide for is that the separate parts be produced in the most economical quantities. From the fact that the parts are produced rapidly by the use of jigs, in many instances the quantity production is overdone, and the money thus tied up in overstock more than offsets that saved by producing in large quantities. This is a point not appreciated by the average foreman, and, indeed, the superintendent himself may have only an indistinct idea of where that point lies beyond which, if he goes, he is putting an extra expense upon the firm. It is evident, therefore, that this is not a matter to be left to chance, but should be taken up and gone through with by some intelligent person who has a thorough knowledge of the shop conditions, and who has above all an accurate cost record of each piece to guide him. The product of his labor should be a list similar to the one shown in Fig. 1 and which is called a "Production Sheet." From this no deviation should be allowed in the number of parts to be produced at a time, until conditions change, necessitating an increase or decrease in the amounts.

Here I wish to make a point of the difference between "lot production" and "quantity production." In lot production, if twelve machines are to be gotten out, there will be made just twelve of the main parts, and perhaps twice that number of details. The only point taken into consideration is to have

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PRODUCTION SHEET

W.P. CALLAHAN & CO. DAYTON, OHIO, U.S.A.

PARTS	AMT.	NO.	D	E	F	G	H	I	PARTS	AMT.	NO.	D	E	F	G	H	I
SUB BASE	1	1	AS ORDERED						IGNITER POINT LONG	1	246	500	——	——	——	——	——
BED	1	2	12	12	12	6	6	3	" " SHORT	1	247	500	——	——	——	——	——
PILLOW BLOCK CAP	2	3	48	48	48	24	24	12	LOOSE GEAR TRIGGER	1	100-A	100	——	100	——	100	——
CYLINDER	1	4	12	12	12	6	6	3	" " SPRING	2	137	500	——	500	——	500	——
" HEAD	1	5	15	15	15	8	8	5	" " " SCR.	1	71-A	500	——	500	——	——	——
" RING	1	7	25	25	25	15	15	10	" " CAP	1	160	100	——	100	——	50	——
FLY WHEEL	2	8	24	24	24	12	12	6	" " OIL CUP	1	249	100	——	100	——	50	——
PULLEY	1	9	25	25	25	15	15	10	GOV. TUBE	1	88	50	50	50	50	50	50
CRANK GEAR	1	10	50	50	50	25	25	15	" " NUT	1	67	200	——	——	——	100	——
LOOSE "	1	11	50	100	——	50	——	25	" ROD	1	98	50	50	50	50	50	50
PISTON	1	12	12	12	12	6	6	3	" REGU. SCREW	1	105	100	——	100	——	50	——
" RINGS	3	13	100	100	100	50	50	25	" " SPRING	1	145	500	——	500	——	500	——
SHAFT CAP	2	14	100	100	100	50	50	24	" BALL SCREWS	2	134	1000	——	——	——	500	——
CHEST BRACKET	1	15	25	25	25	12	12	6	" GEAR KEY	1	128	1000	——	——	——	——	——
" " CAP	2	16	50	50	50	24	21	12	PILLOW BLOCK STUD	4	130	400	——	400	——	200	——
LOOSE GEAR BRACKET	1	17	50	50	50	24	21	12	OILER POST	1	117	50	50	50	25	25	12
CHEST	1	19	25	50	——	25	——	12	" CHAIN	2	BUY THESE						

Fig. 1.

enough and no more to complete the lot; while in quantity production there are four points: First, number used in any given period; second, total cost to produce; third, cost to carry, and fourth, proportion of actual machine time to total time. By considering these points we find that we arrive at entirely different results in the two methods.

Suitable methods should prevail in the tool room, or better, in the jig room, whereby a workman when delivered a jig gets all the necessary tools to perform all the operations upon the piece that the jig is designed to do. It should not be necessary for him to ask for the tools separately, but simply to ask for the jig and tools for such or such an operation, designated either by name or number—preferably by number—and have them delivered to him complete. By doing this, much time will be saved, and mistakes will often be avoided. This can be accomplished by giving each jig, all the loose pieces belonging to the jig and all the special tools, the same number as the piece they are used upon. They should be indexed under this number and kept in suitably grouped compartments and the compartments conspicuously numbered so that they can be easily located. In these compartments is also kept a list, Fig. 2, showing what constitutes a complete set. When a jig is called for, reference is made to the index, if necessary, the compartment found and the complete set of jig and tools delivered with reference to the list, Fig. 2.

DRILLING JIG SET-F 42 C.
1 JIG
1 " LID
4 THUMB NUTS
2 SET SCREWS
6 BUSHES
TWIST DRILLS-$\frac{31}{32}$"-$\frac{3}{4}$"-$\frac{17}{32}$"-$\frac{1}{2}$"
TAP-$\frac{5}{8}$"-10 THREAD MACHINE
REAMER 1" MACHINE
" TAPER-SPECIAL NO. F 39

Fig. 2.

Probably 50 per cent of all jigs are designed to perform two or more operations; and when such is the case, to economize in time and often to obtain the best results in machining, each jig should have its operation sheet, Fig. 3. To illustrate why it is necessary to perform the several operations in a prearranged order: Take for instance two holes intersecting at acute angles, such as a shaft hole and a locking rod hole, where the locking rod hole drills half out into the shaft hole. Ordinarily a workman would drill the larger or shaft hole first, and the locking rod hole afterward. This would be wrong, however, for the locking rod hole drill upon entering the shaft hole and meeting no resistance for half its diameter, would run out and the hole would not be straight.

DRILLINO OPERATION SHEET F 42 C.
DRILL $\frac{41}{42}$
REAM 1"
REVERSE LID AND
DRILL $\frac{17}{32}$
TAP $\frac{5}{8}$ - 10 THREADS
DRILL $\frac{3}{4}$
" $\frac{1}{2}$
REAM $\frac{1}{2}$ SPEC. NO. F 39
NOTE:- CARE MUST BE TAKEN THAT CHIPS DO NOT ACCUMULATE IN CORNERS OF JIG.
NOTE:- DO NOT TIGHTEN TOO MUCH ON SET SCREWS AS THERE IS DANGER OF SPRINGING WORK.

Fig. 3.

A very handy arrangement is to have the tool sheet, Fig. 2, and the operation sheet, Fig. 3, mounted upon opposite sides of a cardboard. They should be of some convenient size, to be determined by the number of separate items it is necessary to put upon them.

It is regrettably too generally the custom to take for granted that a piece is right if it has been jigged, and in this way much work is often spoiled that could be avoided by the simple system of inspecting the first piece of every lot done in a jig and ascertaining its correctness. If the first piece is found to be correct it is reasonably safe to assume that the rest will be. It will be well to provide printed blanks upon which defects and possible improvements in jigs are reported to the tool foreman. These are made out in duplicate by the foreman under whom the defects, etc., are discovered, he keeping the copy and sending the original to the tool room. This method will be found to be superior to giving verbal instructions, as it is a check from one foreman to another. There is an adage which cannot be more appropriately applied than in the case of repairing jigs and keeping tools up, and that is, "don't put off until to-morrow what can be done to-day."

It seems hardly necessary to mention the matter of allowing repairs to be made upon jigs in any other place than the tool room, because it is so obviously wrong that every one must see the fallacy of such a course and what a demoralized state of affairs it will lead to; yet in some shops, where if one were to insinuate such a thing to the management they would throw up their hands in horror, I have seen a man "just taking off the wire edge," or "just easing it up a bit." In this matter there should be absolutely no margin, and it should be considered a misdemeanor, punishable with immediate dismissal, for a workman to assume any part of the tool room duties, however trivial.

If the first thing has been done toward improving the conditions and establishing a system, and that first thing is a competent tool foreman, such matters may safely be intrusted to him, for if he is held responsible for the jigs he will assuredly not tolerate such methods.

* * *

The recently-completed office building of the B. F. Sturtevant Co., Hyde Park, Mass., has four stories and a basement and is of handsome, yet simple design. The interior is finished in oak, while the decorations and fixtures are tasteful and appropriate. The building is heated and ventilated by the Sturtevant fan system, the heated fresh air being conveyed to the rooms through galvanized iron flues built into the walls. The heating and ventilating apparatus is in the basement, where are also the printing plant, and a lunch room for the office employees. The two lower floors are taken up by the business offices, the third floor by the drafting rooms, and the fourth floor is at present used only for the blueprint department. Eight large fireproof vaults give abundant room for the safe-keeping of drawings and other valuable data.

TOOL MAKING.—14.

MILLING MACHINE CUTTERS (Continued).

E. R. MARKHAM

Side Milling Cutters.

Side milling cutters, Fig. 19, are used for cutting the sides or ends of work, as shown in Fig. 20; also for cutting grooves, as, having teeth on the end, the friction is much less. When cutting the teeth on the end, the mill is held on a solid stud in the chuck on nose of spindle of centerhead; or on a plug which fits the tapered hole in the end of the spindle. The stud may be solid, or the end that enters in cutter hole may be made as in Fig. 21, which shows an expanding plug. The end of the mill being cut must not be set parallel with the milling machine table or the top of the tooth will not be of an equal width its entire length. The amount of angularity must be determined by experiment.

The angular cutter for producing the teeth on the end of the mill must be selected with reference to the use to which the cutter is to be put. For general use, a mill that will produce a tooth having an angle of about 60 degrees to the face of tooth answers nicely.

If greater strength is required a cutter that will form a tooth having an angle of 70 degrees may be used.

When cutters of unequal sizes are used together, as in Fig. 22, it is advisable to let the smaller into the larger as represented. If this is not done the teeth at the end of the smaller cutter, where it adjoins the larger, will break away leaving a fin on the work. When cutters of the same, or nearly the same diameter are used, various methods are employed to prevent this result. The more common method consists in making them with interlocking teeth or as it is sometimes

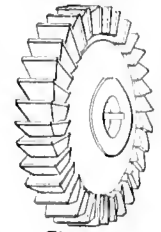

Fig. 19

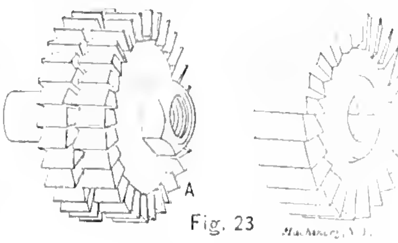

Fig. 23

termed, "dodged" teeth. In some shops every other tooth is cut away; the corresponding tooth on the other being left, projects into the recess. In other shops two, three, or even more teeth are cut away, and then a corresponding number left. These two forms are shown in Fig. 23 at *A* and *B*. For cutting these teeth away the cutter is placed on a solid or on an expanding plug, as when cutting the teeth on the end of a side milling cutter, and a mill of the proper width having a flat face is run through; or a narrow mill is used and the index head revolved to give the desired result. In this form of milling cutter the groove between the projecting teeth should be cut deep enough so that the teeth entering them will not bottom. The cutters should bear against each other on their hubs, as shown in Fig. 24.

A very satisfactory form of slotting cutter, where it is necessary to get adjustment as to width, may be made as in Fig. 25, and in many shops this form has superseded the cutter with interlocking teeth for the purpose mentioned. To make this form of cutter use an eccentric mandrel like that in Fig. 26. This mandrel has two sets of centers; the eccentric centers are located equidistant from the regular centers but on opposite sides, on the opposite ends, as shown. Half of the cutter is placed on the mandrel so the end that is to be cut at an angle shall be half-way between the ends of the mandrel, as shown in Fig. 27. After facing the end *a* by running the mandrel on the concentric centers, the eccentric centers are placed on the lathe centers and the end *b* is faced as shown. The two parts are then put together on a stud and the hole drilled and reamed for the dowel pin, *a*, Fig. 28. The cutter is then placed in the vise of the shaper or planer and the keyway cut, after which the teeth are milled. The necessary adjustment for width of the slot is obtained by blocking apart by means of collars of tin, thin sheet steel, or paper.

When a milling machine cutter is employed cutting a wide, flat surface the chip removed by each tooth is apt to have a length corresponding with the length of the portion of tooth cutting. Removing this long chip brings considerable strain on the cutter and requires a greater amount of power than taking a number of short chips aggregating in length that of the long chip. To accomplish this the surface of cutter teeth is sometimes broken by means of cuts, as in Fig. 29. This process is termed "nicking," and cutters so treated are termed cutters with nicked teeth. Such cutters are specially adapted for milling wide surfaces when heavy cuts are taken. It is

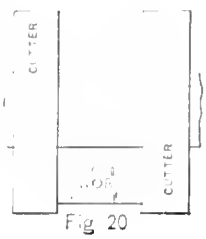

Fig. 20

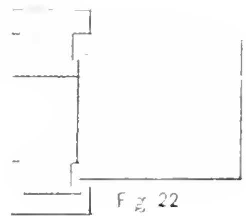

Fig. 22

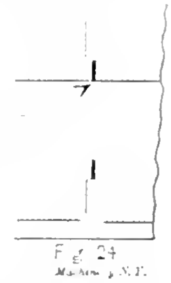

Fig. 24

apparent that the location of the nicks on one tooth must not be in line with those on the adjoining teeth. The nicking may be done as follows. An engine lathe may be geared to cut a thread of the desired pitch—two threads to the inch answers nicely—and a round-nose tool 1/8 inch in width, or a tool similar to a square-thread tool having its corners rounded, may be used to cut the thread. If the latter form of tool is used it must necessarily be thin as we do not wish to cut a wide groove, the desired object being to break the chip. The thickness given for the round nose would answer for the latter form.

The cut should be sufficiently deep to prevent its being ground out, before the tooth has been ground as much as possible before reworking. The thread should be cut before the teeth are milled.

Form Mills.

Cutters of irregular shape whose teeth are not backed off with a forming tool, and which are *not* ground on their faces when sharpening, are in many shops termed "form mills." Such a cutter is shown at *A* and *B*, Fig. 30. If but one mill is to be made the shape is generally produced by blocking out somewhere near to shape with the ordinary lathe tools, then finishing to shape with hand tools. If several cutters of the same design are required a forming tool will be needed. If the necessary facilities are at hand it is made of the form shown in Fig. 31. This is known as a *formed* mill and may be ground on the faces of the teeth without altering their shape. The teeth of cutters of this class should be very

Fig. 21

Fig. 28

Fig. 25

Fig. 26

Fig. 27

coarse; frequently, a 3-inch mill will not have more than seven teeth. These can be made more cheaply in shops provided with machinery adapted for this class of work but very few manufacturers make formed mills in quantities sufficient to warrant the purchase of a machine, which could be used for no other purpose. As a consequence some of the manufacturers of engine lathes make an attachment that can be applied to their lathes, and which answers the purpose nearly as well as a machine made purposely for this work,

unless extremely long mills are to be operated on, or those which subject the machine to great strains.

In the absence of a special machine, or of an attachment, an ordinary engine lathe may be rigged up for this purpose, provided there is one in the shop sufficiently heavy and rigid. It is a serious mistake to take some *old* lathe, so badly worn as to be of little use for any purpose and attempt to convert it into a backing-off lathe, as it will not give satisfactory results. It is cheaper, generally speaking, to get new machinery than to attempt to patch up worn-out machines, especially if they are not adapted to the work at hand.

If the cutters are comparatively short an inexpensive backing-off fixture known as Balzar's backing-off device may be

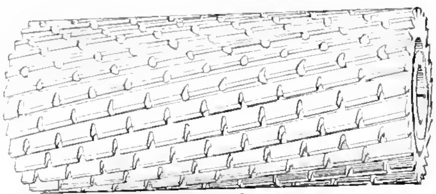

Fig. 29

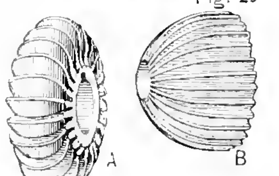

Fig. 30

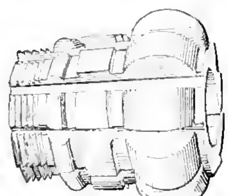

Fig. 31

procured, Fig. 32. This fixture is held between the lathe centers. The cutter being operated on is held on an arbor provided with a key which enters the keyway in the cutter. The keyway must be cut with special reference to the location of the teeth in order that the backing-off which is governed by an eccentric may work in reference to the cutting surface of the tooth. The fixture has a ratchet connected with the arbor. This is operated by a pawl. This ratchet wheel contains ordinarily 36 teeth, so it is apparent that cutters containing 6, 9, 12, 18 or 36 teeth may be backed off on it. Although this fixture has been on the market for a number of years it is not as generally known as it deserves to be. It is not only a useful device but it is an application of mechanical principles that is somewhat novel.

Backing Off Cutter Teeth On a Faceplate.—A method in use in some shops and formerly more commonly used than at

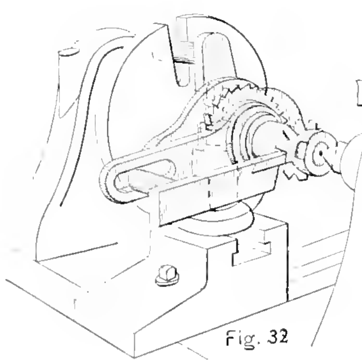

Fig. 32

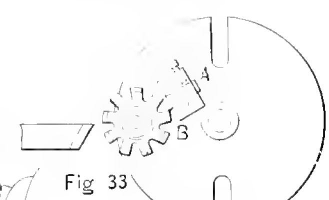

Fig 33

Fig. 34

present, consists in placing the cutter on a stud in the faceplate of a lathe, Fig. 33. It is necessary to provide a finger, one end of which fits into the gashes in the face of the cutter. And, by the way, it is also necessary to cut grooves somewhat narrower than the finish grooves are to be across the face of the cutter after it is formed to shape by means of the forming tool. These grooves are cut in formed mills before backing off the teeth. This cut should be made with an angular cutter of the form shown in Fig. 34.

The cutter is located on the faceplate by means of the finger shown but it must be held while being operated on by the nut on the end of the stud. The forming tool is fed in gradually by means of the cross-feed screw, the lathe spindle being revolved sufficiently to cause the tooth to pass the forming tool, when it may be turned back and the tool fed in for the next cut. Each tooth is operated on separately, being fed in until nearly the desired amount of cutting is done. When all the teeth have been cut in this manner the forming tool is sharpened and a light, finishing cut is taken on each tooth. When using this method cut the grooves somewhat wider than when almost any of the other methods are employed. In fact, they must be somewhat wider than the thickness of the teeth. After backing off it is necessary to mill the *faces* of the teeth about 1-32 inch, to remove the portion at the edge of the tooth that is cut a trifle deeper than the portion just back of it. This is caused by the forming tool drawing in when the cut commences.

Eccentric Backing-off Arbor.—A very simple fixture may be made for backing off cutter teeth. It consists of an eccentric arbor operated by a lever attached to one end. This arbor is shown with and without collars and nut, in Fig. 35. The amount of eccentricity must depend on the size of the cutter to be backed off; for those 4 inches diameter and under ¼ inch answers nicely. The spline cut extending nearly the whole length of the straight part of the arbor is to receive ends of the screws which extend through the collars, thus preventing their turning when pressure is applied to the nut used to fasten the cutter securely on the arbor. The screw to receive the nut on the end of the arbor should be of comparatively fine pitch; 12 threads per inch does very well. The cutter being operated on is not fastened by means of spline, or key, as it is necessary to turn the cutter on the arbor each time a tooth is brought into position.

The cutting is done by moving the lever the required amount, and should be set so as to strike the top of the lathe carriage

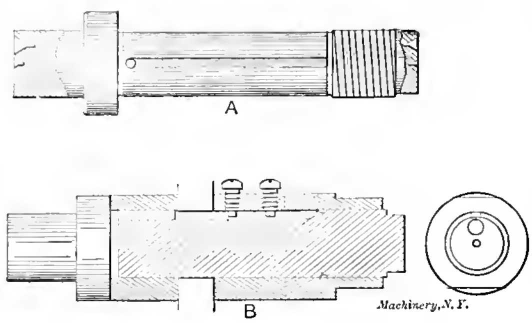

Fig. 35

when at the end of the stroke. To prevent its bruising the carriage of the lathe a strip of leather may be attached to the lower side where it comes in contact with the carriage. When a tooth is brought into position for backing off it should be so located that at the end of the stroke the tooth above it will not come in contact with the forming tool. This is done by lowering the lever so that it rests on the carriage, as shown in Fig. 36, then moving the cutter until the tooth above the one to be backed off rests on a strip of sheet metal placed on top of the forming tool, as shown at *a*. This strip is then removed, the tool withdrawn, the lever elevated, and the tool fed in right for the first cut. It is necessary to remove the tool each time the lever is elevated for return of tooth, and as a consequence a lathe is needed having a cross-feed stop, or a graduated dial on the cross-feed screw. The latter is the more satisfactory.

When using the eccentric arbor observe the same instructions given for using the stud on the faceplate; that is, take the necessary number of cuts on a tooth to bring it nearly to finish before turning to the next tooth.

It is advisable to grind formed mills after hardening and before using. Cutters of this description are ground on the faces of the teeth, and fixtures are used having a guide which properly locates the tooth to be ground by means of a locating finger that gages by the back of the tooth being ground, or against the cutting face of the next tooth, as shown in Fig. 37. Other forms of fixtures have a dial and pin.

Mills should be kept sharp; they dull rapidly when the keen cutting edge is gone, and as there is so broad a face to grind a vast amount of time is consumed if very much stock is to be removed. Then again, the life of the cutter is much shorter under these conditions than if ground when only slightly dull.

Milling Cutters with Inserted Teeth.

Milling cutters exceeding 6 or 8 inches diameter are usually made with inserted teeth; it is cheaper than making of a solid piece of steel, and danger of cracking when hardening is entirely eliminated. If the cutter is narrow, or is to be used for side milling, the grooves to hold the teeth may be straight—at right angles to the end; if the cutter is over 1 inch long make it with teeth that are spiral in form.

As it would not be practicable to make the blades of a shape to fit a spiral slot in the body of the cutter the slots are generally made at an angle to the ends. The blades are made straight, placed in the slots, turned to the required size and then the portion above the body is milled spiraling. If the cut taken with the mill is long or heavy the teeth are nicked as described in section under nicked teeth.

If the grooves that are to receive the blades are to be milled at an angle to the axis of the cutter they should be equidistant from a radial line at each end of the cut; they will of course be on opposite sides of a line drawn parallel to the axis.

Various methods are employed for holding the blades in place. The method used must be decided by those familiar with the character of the work in the individual shop. Fig. 38 shows that used by the Pratt & Whitney Co., Hartford, Conn. Between every second pair of teeth a hole is drilled. This is reamed with a taper reamer to receive a taper pin. After reaming, the slots are cut with a thin metal slitting saw. When the blades are in position the taper pins are driven into the taper holes, closing the stock onto the blades and securely holding them. To remove the blades drive the taper pins out, and the stock springing back to its normal position leaves the cutter free.

The method used by Brown & Sharpe Mfg. Co., Providence, R. I., is illustrated in Fig. 39, and consists of taper bushings and screws, as shown.

A third method is shown in Fig. 40, and is used by the Morse Twist Drill and Machine Co., New Bedford, Mass. To furnish a means of fastening the blades by this method the stock between every second pair of teeth is milled away yet not so deep as the grooves for the cutters. Wedge-shaped pieces of steel are fitted between the teeth, as shown. These binding pieces, however, must not reach the bottom of the cuts made for them. They are drawn to place by fillister-head screws.

It is possible when using inserted-blade cutters to have the blades of high speed steel, which makes it possible to use extremely high speeds and coarse feeds, and thus getting a greater amount of work.

While it is customary to use the circumference of the emery wheel when grinding milling machine cutter teeth for clearance, nevertheless this leaves the clearance edge of the tool somewhat concave in shape, and necessarily weak at the portion where the greatest amount of breaking strain comes. If the wheel used is the largest possible the amount of concavity is, of course, much less than when a small wheel is employed. To overcome this difficulty wheels are made of a shape that allows them to be used as shown in Fig. 41. The cutting is done with the end of the wheel and the cutter is held in a fixture that can be tipped to the desired angle when grinding teeth on the end of a side milling cutter, as shown.

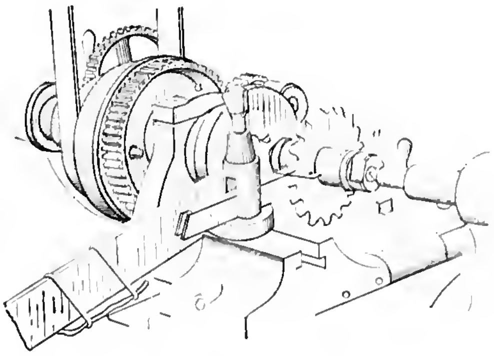

Fig. 36.

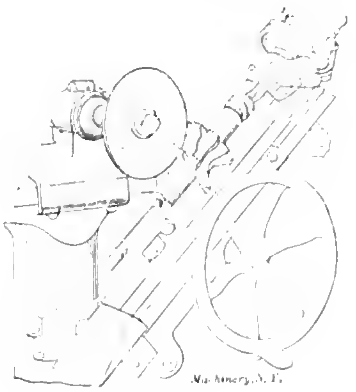

Fig. 37.

Fig. 38

While the cut shows the wheel grinding the teeth on the end of the mill, the teeth on the face may be ground by the use of the same form of wheel. This leaves the clearance at the desired angle and the surface straight rather than concave. To some mechanics this may appear to be straining a point, but the writer's experience convinces him that cutters ground so as to leave the clearance surface straight, rather than concave, will stand severe strains and heavy cuts, with less liability of chipping the cutting edges.

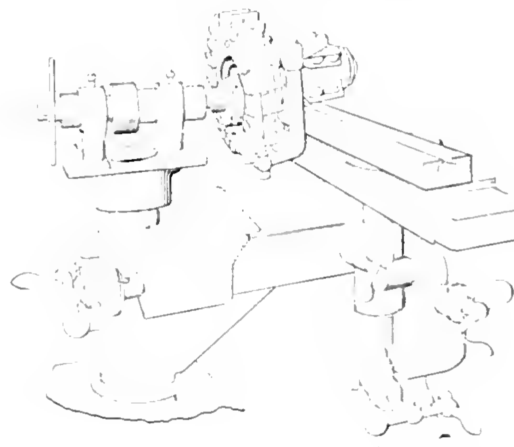

Fig. 41

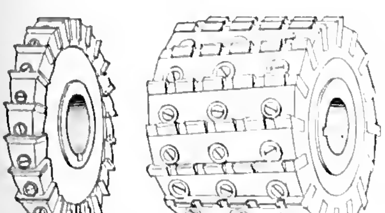

Fig. 39

Fig. 40

While a volume might be written on this subject, it is necessary to conclude, with a few words of caution: Do not make cutter teeth too fine; for many purposes they should be coarser than stated in table in previous article. Do not make them weak; strong teeth may be left much harder than weaker ones; do not overheat cutters when hardening; do not heat them unevenly; do not quench them unevenly in the bath, do not draw temper any more than is necessary; do not draw temper when grinding teeth for clearance; do not use the cutter on an arbor that does not fit the hole in milling machine spindle; do not use on an arbor that does not run true; do not use on an arbor that is smaller than hole in cutter, do not use collars on arbor, if any chips are bedded into their ends, as this would cause the arbor to spring, and the cutter run out

Do not use a nut on end of arbor, unless the end that bears against collars is true with threads on inside. Do not run the cutter at speeds that will cause it to heat and draw temper; on the other hand run at the maximum speed so as to produce the greatest amount of work possible. Do not fail to give the cutter all the feed it will stand. Do not fail to supply a suffi-

cient quantity of lubricant; this not only keeps the cutter cool, but it washes the chips from between the teeth, thus preventing friction. Do not use dull cutters; keep them sharp. Do not attempt to do a piece of milling on a machine, or in a fixture that is not heavy enough for the job. Lastly, do not fail to keep the milling machine well adjusted.

* * *

THE LINDMARK STEAM TURBINE.

It has been known for some time that the De Laval Steam Turbine Co., Stockholm, Sweden, were developing a compound steam turbine for use where greater power is desired than it has been found advisable to attempt to supply with the single-wheel De Laval turbine. This new turbine is made under the patents of T. G. E. Lindmark, the first of which was issued in this country in 1902. Along substantially the same lines as the Lindmark inventions are patents taken out by P. J. Hedlund and consigned to the same company. At present no information concerning the Lindmark turbine is available other than given in the patent records, but inasmuch as a new principle is involved in the operation of this invention, it will be of interest to explain the features of this turbine in so far as is now possible.

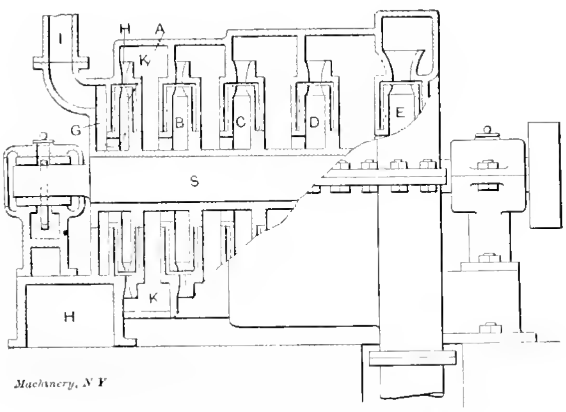

Fig. 1. Section of Lindmark Turbine.

Fig. 1 is a representation of a typical turbine containing the turbine wheels, *A*, *B*, *C*, *D*, and *E*, attached to the shaft, *S*, and rotating with it. Each wheel rotates in a separate compartment and is of the radial outflow type. The steam enters through an inlet pipe, *I*, to the steam space, *G*, whence it flows in the direction of the arrow into the first wheel, *A*. The two sides of the wheel converge at the periphery, forming a contracted outlet, and the steam discharges between curved vanes located in this contracted space, and flows through a diverging annular opening shown at *HH*, which guides the steam into a second compartment at *KK*. This process is repeated in connection with wheels *B*, *C*, *D*, and *E*.

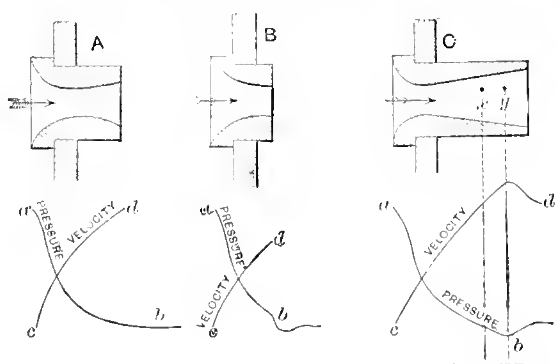

Fig. 2. Action of Steam Discharging from Nozzle under Different Conditions.

Purpose of the Turbine.

The peculiarity of the turbine lies in the pressure and velocity effect upon the steam of the converging and diverging passages as the steam progresses through the turbine. The purpose of the inventor is to transform the potential energy and pressure of the steam into kinetic energy and velocity as it flows through the converging passages of any given wheel, and then to transform the residual kinetic energy and velocity of the steam after it discharges from the wheel into potential energy and pressure during the passage through the annular space, *HH*.

Flow of Steam through Nozzles.

In order to explain the principle whereby this result is accomplished, it will be clearer to first refer to the action of steam in flowing through nozzles of different proportions. In Fig. 2 is shown a converging and diverging nozzle at *A*, through which steam flows from a higher to a lower pressure in the direction of the arrow. The nozzle is supposed to be proportioned so as to give complete expansion, and the pressure will accordingly drop from *a* to *b*, while the velocity will increase from *c* to *d* as indicated by the diagram below the nozzle.

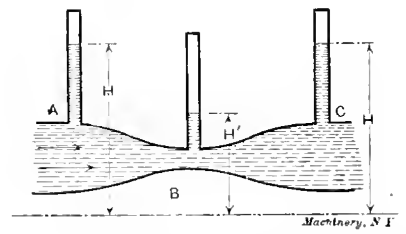

Fig. 3. Illustrating the Analogy of the flow of Water.

At *B* the diverging part of the nozzle is cut away so that the steam does not have the opportunity to fully expand until it has left the nozzle. The pressure, therefore, will gradually drop from *a* to *b*, at which latter point the steam leaves the nozzle and suddenly expands to the lower external pressure, producing a sudden change, *b*, in the curvature of the pressure line. Inasmuch as the expansion is not complete in the nozzle, the velocity line does not rise to as high a point as in the previous case.

At *C* the nozzle is shown lengthened out so as to produce over-expansion; that is to say, when the steam reaches point *x* in the nozzle it is expanded down to the external pressure of the medium into which the nozzle discharges, and beyond this point the steam will expand to a few pounds below the outside pressure until, say, point *y* is reached. After this the pressure will rapidly rise again until it reaches the external pressure at the mouth of the nozzle.

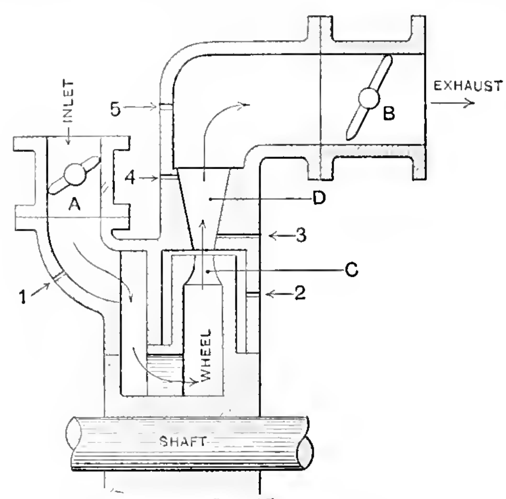

Fig. 4. Enlarged Detail of the Lindmark Turbine.

The Action in the Lindmark Turbine.

It is this latter action which takes place in the diverging passages of the Lindmark turbine. The steam having expanded to a very low pressure appears to follow laws somewhat similar to those governing an inelastic fluid like water, the static pressure and velocity of which change when flowing through a pipe with a varying cross section. Thus, in Fig. 3 is shown a pipe with a contracted section at *B*. Water is flowing in the direction of the arrow and the water rises in the first tube to a height *H* above the datum line. The water must here flow more rapidly in order that the same quantity shall pass through the pipe. This increases its kinetic energy, and consequently must reduce its potential energy, represented by its static pressure, and the water would

stand at a lower level, H', in the tube at this point. At C the flow has decreased again to the original velocity (neglecting friction), and the static pressure is again represented by H.

In like manner, when steam has been expanded to a low pressure and made to flow through a passage of varying section, an increase in the area of the passage will cause a retardation of the velocity of flow, and hence an increase in the pressure; whereas, if the expansion had not been carried to a low pressure, a passage with an increasing area of cross section would cause a decrease in the pressure and an increase in the velocity.

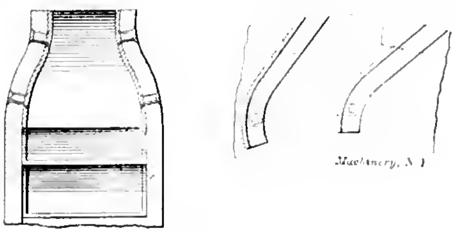

Fig. 5. Vanes of the Turbine.

The application of the principle can still further be explained by referring to the detail sectional sketch of the Lindmark turbine shown in Fig. 4, which represents half of one of the wheels and the connecting passages. Steam enters through the inlet and passes through the wheel in the direction of the arrow, and thence to the exhaust chamber, whence it escapes through the valve, B. Suppose first the turbine wheel to be blocked so that it will not turn, valves A and B to be wide open, and the steam to flow freely through the turbine. At points 1, 2, 3, 4, and 5, are openings to which gages may be attached for determining the pressure at the different points. The steam passages, C and D, will now act like a converging and diverging nozzle. At 1 the entering steam would be at boiler pressure; at 2 the pressure within the wheel casing would be substantially that at the throat of the nozzle, or about 6-10 of the boiler pressure,* at 3 it would be slightly lower; and at 4 nearly as low as the pressure in the exhaust space indicated by the gage at 5.

Action, Wheel Blocked, Exhaust Valve Partially Closed.

Now, suppose valve B to be closed as much as possible without increasing the pressure, 2, within the wheel chamber. The pressure at 1 will obviously remain as before, and the expansion in the passages, C, of the wheel will, as before, carry the pressure at the throat of the nozzle to six-tenths of the initial pressure. After the steam enters the diverging

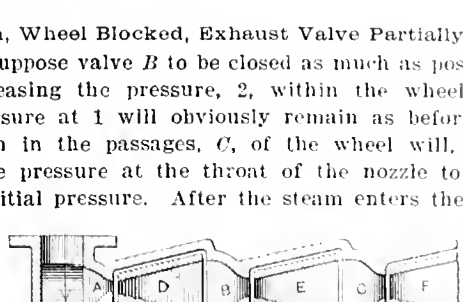

Fig. 6. Hedlund's Invention

space, D, however, over-expansion will occur just as in nozzle, C, Fig. 2. Probably the lowest pressure will be at or near the point where the gage is attached at 3, and from there on the velocity will decrease and the pressure will increase so that the gages at 4 and 5 will indicate a pressure considerably higher than that in the wheel chamber at 2, but lower than the initial pressure at 1.

* According to the well-known law that the pressure at the throat of a nozzle is 58% of the initial pressure, when the discharge takes place in a space the ambient pressure of which is at least 58% of the the initial pressure.

Action with the Wheel Rotating

Finally, if the wheel now be supposed to turn, instead of being blocked as before, and the exhaust valve still be partially closed, the principle of the steam's action will remain the same, the only change being due to the altered velocity of the steam owing to the fact that part of the velocity will be absorbed by the vanes of the rotating wheel. Under these conditions the velocity of flow when the steam reaches the entrance to the diverging portion will be less than before and this will produce an effect, which, according to the experiments of Lindmark, will reduce the pressures somewhat at points 4 and 5.

The Lindmark turbine is a reaction turbine, since the expansion of the steam and increase in velocity occur in the passages of the wheel vanes and the curvature given to them is similar to that employed for reaction wheels of other types. See Fig. 5.

Hedlund's Invention.

The Hedlund invention is the complement of the invention of Lindmark, and is designed to cover the same principle in turbine design, but with the converging passages located in the stationary part of the turbine and the diverging passages located in the rotating parts. In Fig. 6, A, B and C are the stationary converging passages, and D, E and F, the diverging passages in the rotating wheels attached to the shaft, S. In flowing through the turbine the passage of the steam fluctuates as shown in the diagram in the lower part of the figure, its general tendency from beginning to end being downward; while the velocity increases and decreases as indicated, but with an upward tendency.

* * *

GAS ENGINE ECONOMY.

GEORGE MILLER

The question of economy in the consumption of fuel is of great importance to the purchasers of gas or gasoline engines, and incidentally to the manufacturers of those engines, also; for, all things being equal, the firm that builds the most economical engine in the way of fuel consumption, or, in other words, that gives the best results for dollars expended, will get the largest amount of business, and as a corollary thereto, the greatest number of dollars. The question now arises, How shall we get the greatest amount of power out of a given sized engine with a given amount of fuel?

After having spent several years in studying this question and making experiments, and during that time having also built a large number of gas and gasoline engines, the writer of this article is firmly convinced that the position of the igniter in its relation to the charge of gas in the cylinder has far more to do with the economy of gas engines than is generally understood. It is a well-known fact that the charge of gas and air in the cylinder of an engine in operation is more or less stratified; that is, the air and gas are not thoroughly mixed, but portions of the charge are rich and others poor in gas. Someone might ask what difference this makes. When the explosion occurs the charge is entirely consumed and the piston receives its impulse from the expanding gases. The answer to this is: "All the difference between high and low economy in the consumption of fuel." If the charge is ignited at a point where it is rich in gas, the explosion is very sharp and strong and gives an injurious shock to the engine. The exhaust also is liable to be smoky, resulting in a loss of power. If the charge is ignited at a point where it is poor in gas the explosion is too weak, resulting also in a loss of power, to overcome which the engine is fed more gas or gasoline, with a consequent loss in economy. This argument is based on the assumption that the engine was at first fed the proper amount of gas and air to give the most efficient service. Now there are one or more parts of the indrawn charge where the air and gas are in exactly the right proportions. If the igniter can be brought in contact with the charge at this part the result is the greatest economy and efficiency.

It has been said by a prominent writer on gas engines that in designing a gas engine we can never be sure beforehand what the results will be. He says that an engine of given dimensions should develop a certain horse power, but when the engine is built and put in operation the result may be

very disappointing. In other words, the whole science of gas engine building, according to the writer, is a mere matter of guess work. Now I contend that this is wrong,—the science of gas engine building should be as exact as is the science of steam engine building. Imagine a man of to-day experimenting on steam engines in order to find out what size is required to run a certain plant! It is not for one instant claimed that the builders of gas engines have not advanced scientifically and intelligently in the direction of accurate knowledge as to the working of gas engines, nor do I claim that the placing of the Igniter in the proper position on the cylinder would put this industry among the exact sciences, but I do claim that it would make a great advance toward that end.

When a charge of gas and air enters the cylinder, it is more or less thoroughly mixed, and the path it takes is governed by the shape and position of the inlet valve and also by the shape of the cored passages, so that the richest part of the charge will vary more or less in position in the same type of engine, giving more or less economy, unless the passages are machined of an exact size or very carefully molded. Competition is too keen nowadays for manufacturers to enter carefully into these details. The chief trouble, however, with most gas engine ignition does not lie in any inaccuracy in the inlet passages, but in the fact that the igniter is put in "any old place." As long as the charge ignites, some manufacturers—and their name is legion—think the engine is all right, not knowing that it is on the proper placing of the igniter that the engine mainly depends for its efficiency and economy. It is this false policy that has brought the gas engine rather into disrepute and lessened its sale. The writer is convinced that if this matter were properly attended to, and the scientific placing of the igniter more thoroughly understood, it would result in a greatly increased sale of gas engines. Some makers claim that the best point of ignition is right in the center of the charge, so as to ignite it in its entirety as rapidly as possible, but, as was said before, this depends upon the richness of the charge at that point. Moreover, the same principle should be applied to gas engines as is applied to guns. A small engine, like an army rifle, should have a sharper and more sudden explosion, and a large engine, like a cannon, should have a slower explosion, corresponding to the slow-burning powder used in large guns. This makes them run smoothly and without shock.

The explosion in the cylinder is of an exceedingly high thermal efficiency, but it lasts only a short time and drops quickly to a very low point. In small engines of high speed a large amount of firing lead should be given, so as to take advantage of this high efficiency at the proper moment and not lose any of the resulting heat units. The explosion and combustion of the charge in this case must be more sudden, hence the igniter should be placed at a point where the charge is slightly richer in gas. The collapse of the explosion and loss in heat units is also very sudden, and unless advantage is taken of these facts there is a great loss of power. As the engines increase in size the explosion and combustion of the charge must be slower, and the point of highest thermal efficiency must be later; otherwise the engine will receive a sudden and severe shock that is very injurious to the working parts. If it is sought to overcome this by giving the engine less lead, the result will be loss of power. Now some manufacturers go ahead blindly and put the igniter in the same relative position on all their engines, irrespective of design or size, with the result that a few run over and a large number run under the expected horse power.

Let me here give an experience that came under my personal notice. A certain shop in Canada had been building gas engines designed by an expert. The igniter was directly on the top of the cylinder, a position which was soon condemned, as it was almost impossible to start the engine in cold weather without first warming the cylinder, since the gasoline vapor, being heavier than air, would not rise to the igniter. It was therefore decided to place the igniter as low down on the side of the cylinder as possible, which as can readily be seen, was an even worse position than the former, for I found by actual test that the consumption of gas was greatly increased. Several of these engines with the low igniter were built and sent out and shortly after returned to the shop because they used too much gas. Although the igniter in its new position was far closer to the inlet valve, yet the charge passed by the igniter and became stratified in another part of the cylinder, leaving the part around the igniter very poor in gas. To overcome this, it was decided to place a hood inside the head, over the inlet valve, in order to deflect the charge against the igniter. What was the result? The charge at the igniter was so rich in gas that when the explosion occurred it was so early and severe that the shock in the engine could be heard quite a distance away, and would soon have made the engine fit only for the scrap pile. The only thing to do in this case was to give very little lead to the engine with a consequent large loss of power. At my earnest solicitation the igniter was raised up a little and we had a test of the two styles. Both engines were of 8-inch bore and 16-inch stroke. The engine with the low-down igniter was running a chopper and all that could be got out of it was fifteen bags of chop an hour with the engine loaded to its limit. We removed that cylinder and replaced it with one that had the igniter raised.

At the first test with this engine we chopped thirty-four hags of chop in one hour, and at a second test we chopped thirty-two bags in one hour. In this latter trial the engine was not loaded to its limit, so could have done even better, and this was accomplished with nearly 25 per cent. less gas than the other style of cylinder required to chop fifteen bags. I also took a break test of the engine with the igniter raised and it gave 24.4 horse power. Not a bad showing for an engine of that size.

If it were possible to build a four-cycle engine in which the charge could be thoroughly mixed before ignition the question of the position of the igniter would not be of nearly so much importance. But engines are now built to run at two, three, or four hundred revolutions per minute, and competition being so keen, the question of cheapness of manufacture is of vital importance. Attempts more or less successful—generally less—have been made to overcome the difficulty, but most manufacturers and purchasers of gas engines want them as simple as can be made and with as few clap-traps as possible. This being the case, the writer is convinced that the only way to get the maximum amount of power with the minimum consumption of fuel is to place the igniter on the engine according to the size of the engine and the design of the inlet valve and passages, so that the charge that comes in contact with the igniter will be of the proper mixture for each particular size and design. When this is done a gasoline engine will run as smoothly and quietly as a steam engine, without the slightest shock, and with the added advantage that there will be a considerable increase in power, and a greatly increased economy in the consumption of fuel over present makes of gasoline engines.

* * *

BENDING ANGLES AND STRUCTURAL SHAPES.

FRANK B. KLEINHANS

Considerable difficulty is experienced in bending angles into circles for tanks, etc. The angles are bent either as shown in Fig. 1 with the leg extending in, or like Fig. 2 with the leg extending out, but unless the work is done properly, the

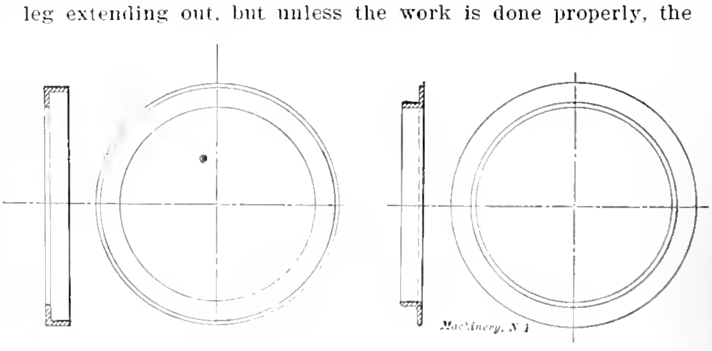

Fig. 1. Fig. 2.

legs of the angles will not lie flat, being dished in or out as the case may be. In bending an angle as shown in Fig. 3, the lower portion A must be stretched and the top portion B must be compressed. On account of the fillet F, the bottom

roll will have only a short bearing along the flat portion between the fillets, while the top roll will have a bearing over the full face of the angle. The center of gravity of the downward thrust is not in the same plane as the center of gravity of the upward thrust, and on account of these forces acting in different planes the angle will twist, and when it is bent will not lie flat. This difficulty is not easily remedied on every style of bender, but usually it is possible to rig up a bender with special attachment which will turn out satisfactory work.

There are two general types of benders, the double housing type and the overhung type. Benders of the double housing type have the rolls between two housings, the driving gear being placed next to the rolls or outside the housing. These machines can bend very heavy material in comparison with

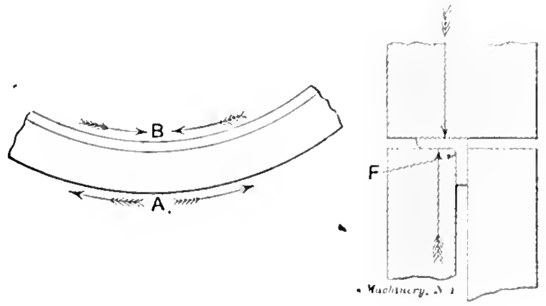

Fig. 3.

their weight, but to offset this the rolls are hard to change, and the material after it has been bent, is not easily taken out of the machine. Benders of the overhung type are heavy machines in comparison with the stock which they will bend. To offset this, however, the rolls are easily adjusted and can readily be taken off and replaced with rolls of a different shape. Whichever type of machine is used for bending, the grooved rolls should be made in separate pieces as shown in

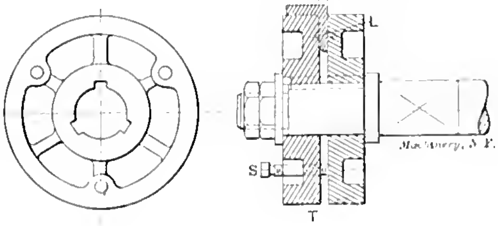

Fig. 4.

Fig. 4. Some form of adjustment, as a setscrew *S*, should be provided for changing the width of the slot *T*, and the rolls should then be adjusted so that the leg *L* of the angle *A* has little if any play. It is convenient in bending angles to have all these rolls arranged with adjustment similar to that in Fig. 4. One can then bend an angle into a circle with the leg either in or out as shown in Figs. 1 and 2, though with the machine arranged in this way it is still almost impossible to bend angles so that they will lie flat.

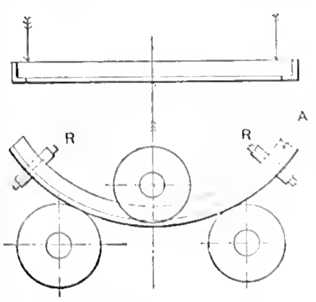

Fig. 5.

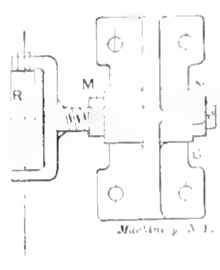

Fig. 6

Fig. 5 shows a set of bending rolls where *A* is an angle which has been bent as shown, and *R* and *R* are rollers attached to the housing of the machine. As the angle is being bent, the dished side will bend toward or away from the housing, according to the way in which it is passed through the machine. The angle is now entered into the machine so that the dished side will bend toward the housing. The rolls *R* and *R* are adjusted against the angle and the angle is run through the rolls back and forth, the guide rollers *R* and *R* being screwed out until the angle, after it is bent, has all the dish taken out of it. A person can soon become experienced enough to bend angles which will lie on a flat surface. Fig. 6 shows a detail arrangement of a guide roller, *R*, with the adjusting nuts *M* and *N*. The bracket *B* is either bolted or cast solid on the housing. Fig. 7 shows the top roll *T* adjusted out over the angle to be bent. In bending light angles on machines which have light rolls, the leg will sometimes buckle. To prevent this a separate guide angle *G* is run in alongside of the angle *A*, to keep the leg from buckling and twisting out of shape, and this in a measure serves the purpose of the guide rolls.

In bending tees, channels and rails, the rolls gradually become worn, then the work will be sure to be cupped one way or the other. Sometimes this can be corrected by adjusting the rolls, but frequently the guide rolls, Figs. 5 and 6, are required for bending the work into a perfect plane. In reference

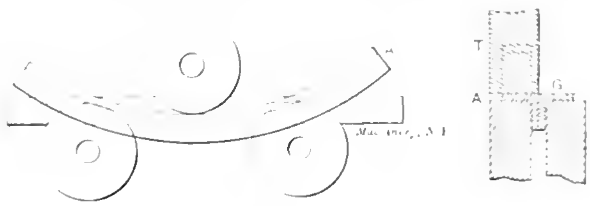

Fig. 7.

to bending rails it might be well to mention that owing to the heavy sections there is little spring in the rails in the short length between the lower rolls. For this reason the rolls will either grip the material so as to stall the machine or else the rolls will slip, especially where the top roll is idle. If the top roll is driven, however, the rail will be drawn through the rolls better and the bending action will be more uniform, though there is always more or less slip between the rolls and the section which is being bent. The scale often snaps away from the material and catches between the section and the rolls, and thus the surface of the rolls becomes badly worn. For this reason it is well to have the rolls chilled, and moreover, since the chilled surface is very hard, there will be less likelihood of chipping or breaking the edges and corners.

* * *

ELECTRIC REPAIRING.

ARMATURE COILS.

NORMAN O. MEADE

An illustration of an armature coil of the most common type now in use, is given in Fig. 1. This coil requires somewhat more labor to prepare than does the rectangular form, but is much easier to use when rewinding armatures, as no portion of it passes over the end; and it has the further advantage of allowing better ventilation. Another type in use is the plain, rectangular form, shown in Fig. 6. Such a coil

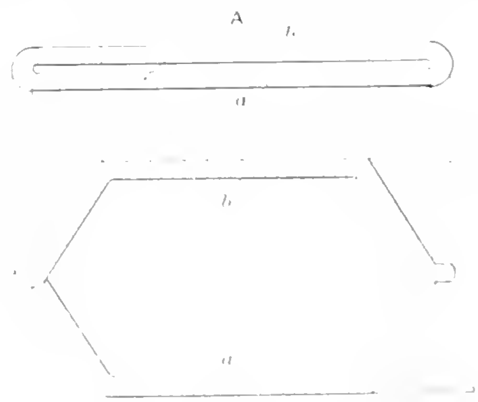

Fig. 1

is easily made, but requires considerable manipulation after it is placed in the armature. The forms over which these two styles of coils are wound are similar in design but different in shape. Fig. 2 shows a form, in which *a* is a standard fastened to bench or floor, and a slot is cut down through the center of this standard to a point two or three inches below the crank. A small bolt, *L* with thumb-nut, is provided, to place a tension on the crank, by drawing up the slot. This is

plainly shown in the figure. For the form proper we require a piece of hard wood, *b*, rounded at the ends, *d* and *d'*, the size and shape of this piece conforming to the interior of the coil to be wound; and two side pieces of wood, *c* and *c'*, slightly greater in dimensions than the center piece, so that when placed on either side concentrically with the center, a spool is formed. The side, *c*, is fastened permanently to *b*, while *c'* is held in place by two thumb-nuts, *e* and *e'*, which allows the coil to be readily detached from the form.

The flange, *f*, is attached to the short shaft with crank and handle, *j*. The illustration shows both plan and side views.

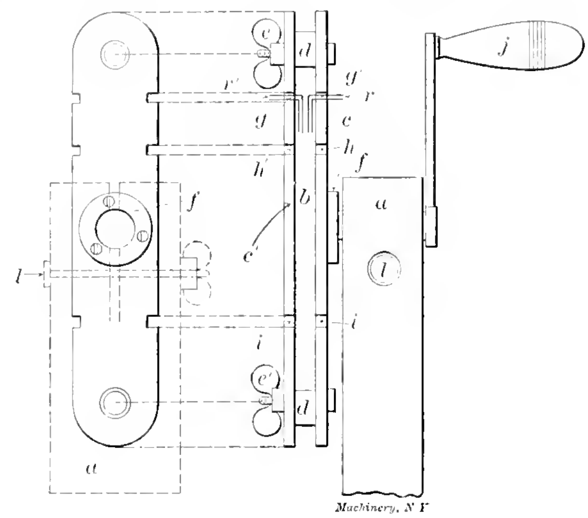

Fig. 2.

The notches, *g* and *g'*, *h* and *h'*, *i* and *i'*, are for fastening the ends of the wire and for the retaining strips, which will be explained later.

Fig. 3 gives plan and end views of the shaper for shaping coils of the style shown in Fig. 1, in which *g* is the wood base, *a* is the coil that has been shaped, *b* and *b'* the clamps; *c*, *d*, *e* and *f* the wood strips, of the shape indicated. The pieces *d* and *e* are fastened to the base, *g*, by screws. The operation of this shaper will be taken up in its turn.

Fig. 4 represents a reel of magnet wire, *a*, swung on a suitable support, *b*, and provided with a tension. The tension consists of a piece of hard brass wire, about No. 10 or 12, fastened to base *b* and passing around a groove in one side of the reel

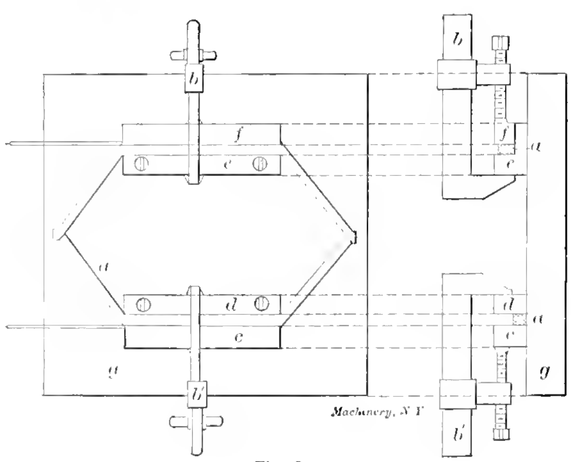

Fig. 3.

to a weight, *d*. With the wire, *e*, paying off in the direction indicated, the desired amount of tension may be placed on the reel by varying the size of the weight.

Fig. 5 represents a handle for guiding the wire onto the form. This handle should be made of fiber or hard wood. The end, *c*, is beveled off as shown. A hole or slot, *b*, extends through the handle, through which the wires pass. The handle is held in the left hand, while the form is rotated with the right hand by means of the crank already mentioned.

Some styles of coils are wound with two or more wires laid on in parallel at one time. The reason for this is that in machines of considerable size, a single conductor of sufficient carrying capacity would be too stiff for handling. Under such conditions the handle should have a slot at *b* instead of a hole, and a separate reel for each conductor should be provided, one placed back of the other.

The materials used in armature coils are: Double, cotton-covered magnet wire, ½ or ¾-inch cotton tape, insulating tape, a good quality of orange shellac, and some strips of 1-32-inch sheet brass. The cotton tape can be procured at any department store in rolls of various sizes.

A drying oven is an essential part of an electrical repair shop, and when there is steam or gas in the building it is an easy matter to provide one. Its capacity must be determined by the size and quantity of the work to be done. An angle-iron frame, with 1-16-inch iron or steel lagging for siding and doors, makes an excellent oven. The doors should be on the front and extend from top to bottom. The interior of the oven must be provided at the lower portion with a suitable stand for holding armatures, and above the stand metal racks, for drying coils and commutators. Steam coils or gas burners may be used for heating the oven. A good temperature for drying is about 200 degrees F. Too much care cannot be taken in following the dimensions of old coils, as a little variation will cause trouble when placing the new coils in an armature.

In general, do not use metal for driving wires into place; use hard wood or fiber. If any bare spots appear in course of winding, insulate them at once. Do not cut the ends of the wire too short. It is easier to cut off a little more than to splice on. Tape the coils tightly and let the convolutions lap well, so that they will not pull apart when shaped. The lead wires, or ends of coils, should be carefully covered with insulating tape. Soldering in of lead wires is greatly facilltated by tinning the ends before driving them into the com-

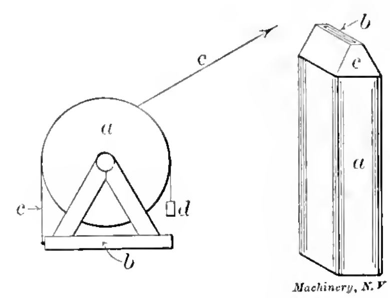

Fig. 4. Fig. 5.

mutator slots. The beginner, undoubtedly, will have to make several attempts before completing a perfect coil. Neatness is of great importance, and every portion should be well done before proceeding further.

We will now wind and insulate a coil, and follow out each detail. Assume that a set of coils, similar to that shown in Fig. 1, is to be made. It is supposed that the winder has one of the old coils for inspection. With a wire-gage determine the size of wire, and note whether one or more wires are run in parallel for one conductor. This done, carefully unwind one turn and measure its length; this will be the circumference of the form to wind the new coil on. A coil of this style should be wound on a long, narrow form, similar to that shown in Fig. 2. Some armatures have two coils per slot, that is, two coils made up as one, with their respective ends brought out separately. Consider that we are about to wind a double coil, with two wires in parallel for one conductor. This will necessitate winding on four wires at one time.

Arrange four reels of magnet wire, one back of the other, and push the four ends through the slot in one guide. Suppose the desired length of the armature leads, or coil ends, to be six inches. Now bend at right angles the two right-hand wires, about six inches from the ends passed through the guide, then bend the two left-hand wires in the opposite direction. This being done, slip the two pairs of bent ends into the slots *g* and *g'* in the manner shown at *r* and *r'*, Fig. 2. Say that the coil is four convolutions wide and three layers deep. Having secured the ends as described, turn the crank two and one-half times, bringing the outer ends of the coil through the slots on the opposite side to *g* and *g'*, using care to retain the ends in their original order. During the winding

process the guide should be held firmly in the left hand, and the wires pulled down tightly into the form. Now cut off the wires from the reels, leaving six-inch ends on the coil, as at the beginning.

Cut four narrow strips of 1-32-inch brass, about 1 inch long, and slip one under the coil through the slots *h* and *h'*, *i* and *i'*, and also through the four corresponding slots on the opposite side of the form. Bend the strips up over the coil, and tap down lightly with a mallet, taking care not to break the insulation. Loosen the thumb-nuts, *e* and *e'*, slip off the side *c'*, and remove the coil. Make up the desired number of coils in this manner before insulating them. Having completed the winding, cover with good insulating tape the four ends—that is, the eight wires. These leads should be covered from the point where they bend through slots in the form, to about one inch from the end.

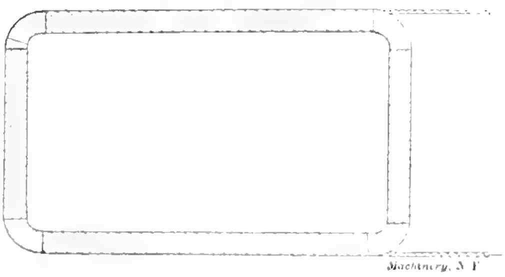

Fig. 6.

The next operation is to carefully wrap the whole coil with cotton tape, giving it the appearance shown in Fig. 1. The leads must be left protruding the distance covered with insulating tape.

We will now shape the coil, as in Fig. 3. The two halves of the coil, after being taped, should be pressed closer together, giving the coil the appearance shown at *A*, Fig. 1. Insert one of the halves between the strips *c* and *d*, and clamp it tightly. With the protruding half grasped with both hands, pull it over the strip, *c*, and clamp as shown. With a small fiber mallet, pound the ends into symmetrical shape. Remove from shaper, and immerse in a suitable receptacle filled with thin shellac. When thoroughly impregnated, allow superfluous shellac to drip off, and place in oven to bake.

The rectangular coil shown in Fig. 6 can be made on a form similar to the one described, having its dimensions correspond to the shape of the coil.

A little practice will render the workman proficient, and enable him to turn out as good work as can be purchased from electric manufacturing companies.

* * *

THE AMERICAN BLOWER CO.'S NEW ENGINE.

The small vertical engine shown in the two views herewith has recently been placed on the market by the American Blower Co., Detroit, Mich., for continuous operation and heavy duty as in driving blowers, dynamos, pumps, etc. From Fig. 1 it will be seen that it is fully enclosed, preventing foreign matter getting into the working parts; all these parts are accessible by turning a milled hand nut and lifting out the enclosing plates. The builders state that for the past two years they have been experimenting with this engine, and in this connection they inform us that an engine was adjusted and filled with oil on March 10 and that up to July 15 no adjustments of any kind had been made, and no oil added except to fill the sight-feed cylinder lubricator. They further state that it has been operating from 14 to 16 hours per day, driving a blower, and that after a lapse of over four months it needed no adjustment or fresh lubricant, running almost as noiselessly as at first. Fig. 2 illustrates the oiling system, which is a special feature of this engine.

Referring to the half-tone, Fig. 2, the operation is as follows: An eccentric, *K*, on the shaft, actuates the plunger, *L*, of the oil pump, *A*, forcing the oil up through the tube *B* into the small strainer, *C*. From *C* it drops into an oil box through the bottom of which four tubes project. In one side of each of these tubes is a slot, so that if the oil box contains only a small amount of oil, each tube can take its proper proportion. If the box is full, all the tubes get more oil in proportion to the increased height. Two of these tubes, *F* and *C*, and two on the opposite side, not lettered, apply oil to the guides, the oil dropping into a small trench, *G*, from which it runs into the bearing through a small oil hole. The crosshead pin is supplied by the tube *E*; the oil drops into the cup, *H*, and the cavity between the bolt and inside of crosshead pin and the oil grooves. The oil dropping from the crosshead is caught in two pans attached to the inside of the covers, from which it runs down the inside of the cover and drops into a cup in the

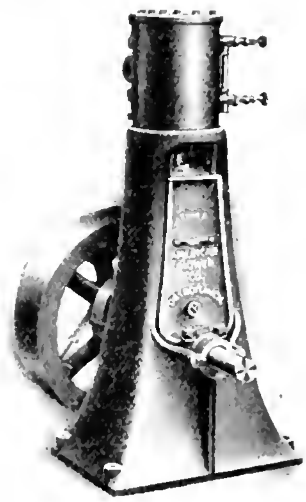
Fig. 1

top of the main bearing cap. There are no oil grooves at top and bottom of the main bearing, as is customary, but the bearing is cut away at the joint. When the strain from the connecting rod is up the oil is carried to the bottom of the bearing, but when the load is reversed there are no oil grooves to carry away this oil. The crankpin is oiled through tube *D*, which discharges into a crank oil ring inside the eccentric, *K*, which, in turn, discharges into the crankpin oil tube, and flows across the crankpin bearing. The crankpin oil ring, in addition to its independent supply, catches the drip from one


Fig. 2

end of the main bearing; the eccentric is oiled from the drip which it catches from the other end. No difficulty has been experienced in catching the oil thrown off the eccentric strap. A portion of the oil, as it drops back into the bottom of the frame, enters an oil filter thoroughly cleaned and purified.

* * *

Electric power generated at Niagara Falls was first used commercially by the Pittsburg Reduction Company, August 26, 1895. Work on the development of the power station was started by the Niagara Falls Power Company October 4, 1890, and work on the tunnel tailrace was carried on unceasingly for nearly five years.

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JIGS AND FIXTURES—HOW DEFINED?

We have been asked to define the words "jig" and "fixture" as applied to machine tool equipment, and to advise which word, in our opinion, is preferable. A glance at the definitions of these words in the Standard and Century dictionaries soon convinced us that the learned gentlemen who compiled these excellent works had not given the important subject of interchangeable manufacturing a great deal of their attention. The Standard says that a jig is "any tool or fixture used in the manufacture of duplicate parts to guide cutting tools so that their operations shall be the same on each; as a drilling-jig, or a milling-jig." No definition of fixture, in this sense, is given whatever, and the Century ignores both words as applied to duplicate manufacturing. Hence it was "up to us" to determine the meaning and limitation of each word as used in the shop and trade literature, and we find it to be by no means an easy matter.

In the first place jig and fixture are words used interchangeably; a drilling-jig and a drilling-fixture may be one and the same thing—and they may be different, as we shall see later. Broadly, a jig is a device used in interchangeable manufacturing of machine parts *for holding the work pieces* and *guiding cutting tools* in any machining operation thereon; hence it may be used for drilling, boring, milling, planing, shaping, etc., but, we believe, it is preferably limited in general use to the first two operations, that is, drilling and boring.

While fixture is a term generally used to mean the same things, we believe that it is more comprehensive, and that it includes a lot of things which would not ordinarily be called jigs. In this we take issue with Mr. Mirrielees, who in another part of this issue uses the word jig throughout his article to include all templets, fixtures, appliances, etc. Now if the device is of such a nature that it incloses and holds the work so that it can be lifted and transported as a whole, and, perhaps, has provision for a number of operations in different planes, we should surely call it a jig, but if it were the radius attachment to a planer for planing locomotive links, we should call it a fixture, although it is by no means a fixed or permanent part of the machine. A drilling vise is more of a fixture than a jig, but if it is provided with guide bushings we would term it a drill-jig or a jig-vise. Again a fixture may be one of the tools of a machine, as for example, the tools and fixtures of a turret lathe. A tool-post is an example of a fixture, but it is not a jig in the ordinary sense of the word. An "old man" for ratchet drilling is a fixture, as is also a former used on a planer as in planing relief for locomotive driving boxes, or as applied to the lathe for turning machine handles. A bending device which insures exact duplication is usually called a fixture, in preference to jig. A device for holding work pieces on the milling machine so as to insure duplication of parts, is preferably called a fixture, although in many shops it would be called a jig. Hence the difficulty in assigning any definite and limiting meaning for either term.

One difference that may be assumed to exist between jig and fixture is that a jig holds the work and guides the cutting tool *independently* of the machine supplying the driving power and feed, while the fixture is usually dependent upon the machine to guide the cutting tool or the work; one is self-contained and the other is not. We are fully aware that this distinction does not exist in actual practice, but it is one put forward as a suggestion for those shops which wish to define shop terms precisely.

* * *

IMPROVED LUBRICATION.

Improved lubrication is a feature of modern machine design that is one cause of greatly increased efficiency. In the old time machines the builders were often content with merely a hole drilled through the top of the bearing, through which an occasional squirt of oil could be injected. With slow-moving parts this makeshift lubrication permitted machinery to be run without actually grinding out the journals, but the frictional resistance was high and wear comparatively rapid; with modern high-speed machinery it is necessary to have something better. Following the primitive oil hole came the self-feeding oil cup which required to be filled only at intervals and maintained a steady supply, drop by drop, of oil upon the bearing. Where there are a great number of bearings, the filling and supervision of a large number of oil cups requires much time, and if any one oil cup is neglected, a hot bearing may result, causing the shutting down of an important machine. In many cases, especially in central power plants, no chances can be taken from interruptions of service, and lubricating systems have been developed by which oil is pumped from one source through pipes to all the various bearings that require lubrication. Instead of being content with drop by drop lubrication it has come to be the custom to flood the bearings with oil, which, of course, is returned to the central system to be pumped over again. The temperature of bearings can be kept several degrees cooler in this way, and the coefficient of friction may be materially reduced. But with this system of oil distribution on steam engines it has not heretofore been considered feasible to lubricate all the main working parts in the manner described. Recently, however, an improved form of steam engine was put on the market which has a crankshaft made so that the oil injected into the main bearings travels thence through the crankshaft to the crank-pin, and from the crank-pin through a hollow connecting rod to the crosshead bearing and the guides. The valve stem guides also receive lubrication from the crosshead guides. Tests have shown the efficiency of the engine as a machine to be considerably increased, and, of course, all bearings by this system are working under almost ideal conditions as regards lubrication. Hence there should be practically no trouble from hot journals or cut boxes.

* * *

The Electric Controller & Supply Co., Cleveland, O., recently wished to relieve their representative at the Louisiana Purchase Exposition, and as a means of selecting the best man to take the position inaugurated a contest among their draftsmen. The contest consisted of two written articles and the award was made as follows: 40 points were counted for the clearest description of a certain specified apparatus; 30 points for the best statement of the advantages of the apparatus from the standpoint of a customer; and 30 points for the best composition from the standpoint of rhetoric and grammar. The competition was won by Mr. George W. Magelhaes, formerly a student of the Case School of Applied Science, and later of Columbia University.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

A reinforced concrete chimney 182 feet high has recently been completed for the Portland Cement Co., of Belleview, Mich. The *Engineering News* states that the structure is monolithic throughout, the reinforcement being on the Weber system, using light steel bars of T-section. The interior diameter of the chimney is 8 feet.

The rival of the locomotive, the high-speed automobile, has again lowered its record, the quickest mile to date being that made by H. C. Bowden on a mile straightaway course at Ormond, Fla., January 15. With a 90 horse power French machine Mr. Bowden made a mile in 37 seconds against a stiff northeast wind. The track is located on the beach, where the sand, by the action of the wind and waves, is made remarkably smooth and hard, forming an ideal course for automobile speeding.

The Butterick Publishing Company, New York, have what is said to be the largest electric sign in existence on the west side of their new building overlooking the Hudson River. It consists of the word "Butterick" in enormous letters extending across the length of the structure and of a height proportional to their width, the "B" being nearly six stories high. The lamps lighting the sign are divided into three sections, each section of three letters being on independent circuits controlled by switches on the power plant switchboard. Incidentally this arrangement went wrong one night, one of the circuits failing to work through the blowing of a fuse or some other defect, and the New Jersey commuters crossing the river were amused to see this enormous sign advertising "Butter."

A useful method of repairing cracks in castings, such as locomotive cylinders is described by a correspondent of the *American Engineer*. Where a crack is to be drawn together the ordinary method is to bolt forgings with projecting ears on each side of the crack and through these ears put bolts for drawing the adjacent sides together. This makes a clumsy looking job and in some cases it is difficult to get the necessary strength in the repair to hold the parts firmly in place. The alternative method referred to by the correspondent is as follows: A piece of iron $1\frac{1}{4}$ inches thick was turned to about 8 inches in diameter and then cut through the center, making two semi-circular pieces. These were fastened by $\frac{7}{8}$ inch patch-bolts on either side of the crack in such a position that their contours would form a circle. The cut through the center represents about the allowance for drawing the crack together. A heavy band of iron was then shrunk on the pieces, drawing the crack tightly together and making a steam-tight joint. This method of cylinder repair does not interfere with the jacket; as the lagging can be fitted around it, making the top of the plate flush.

The new *Times* building is the last word to date in the matter of tall buildings in New York City, being over 9 feet higher than the Park Row building when measured from its lowest basement floor, 57 feet below the street, to the topmost point. The *Times* building measures 419 feet 9 inches over all and the Park Row building 410 feet, but the Park Row building is higher from the curb line, being 380 feet, while the *Times* building is 362 feet 8 inches. This building is notable in more ways than one, however. It is situated on a trapezoidal plot of land bounded by Broadway, Seventh Avenue, Forty-second and Forty-third Streets, thus giving the building the advantage of light on all sides and the unique distinction of having more than three times the area in vault space than the nominal area of the lot. The area of the building lot is 5,405 square feet; total area including vaults, which go to the curb line, 17,633 square feet. The New York Subway traverses one corner of the upper basement, and a local station at this point permits the tenants of the building to enter the Subway without going on the street. The building contains a total floor space of 116,349 square feet, 3,712 tons of structural steel, a smokestack 389 feet high, a 30-ton steel girder, the heaviest girder ever used in the construction of an office building, an elevator rise of 326 feet, and many other features of notable distinction. The printing is done in the sub-basement where there are four Hoe octuple presses having a theoretical capacity of 192,000 16-page papers an hour, but an actual output of about 144,000 on account of delays from stops, changing rolls, breaks in the web, etc.

In view of the fact that New York City is experimenting extensively with wood pavement, the report of U. S. Consul Hamm of Hull, England, on wood pavements in that city is of much interest to municipal officers responsible for the maintenance of streets. Hull now has thirteen miles of wood pavement, and wood is being substituted for granite blocks in streets originally paved with the latter material, its use beginning in that city in 1875. The woods which have given the best satisfaction are obtained in West Australia, and are known as "jarrah" and "karri." The blocks are cut 3 inches thick, $4\frac{3}{8}$ inches wide, and 9 inches long, and are dipped on one side and end in a hot mixture of pitch and tar. They are laid close together, edge up, that is with the grain standing vertically, and the joints are run full of the hot mixture of pitch and tar. The pavement is frequently sprinkled with coarse grit, which tends to give a continuous surface almost as hard as granite. Wood pavement laid in Hull in 1894 is still in good condition, but the principal reason for their durability is the fact that a first-class foundation of cement concrete 7 inches thick is first put down, and this is faced with Portland cement mortar, three parts sand and one part cement, which forms a perfectly smooth surface for the blocks, and supports them rigidly under heavy loads.

A new method of laying electric cables which has been adopted in the Poplar district of London, in lieu of the system of inclosing the cable in an iron or earthenware conduit, is described in the *Scientific American*. The cables are laid separately in a corresponding number of light steel pipes. These pipes are coated upon the exterior with a special preparation in which paraffin wax predominates. They are made in 5-foot lengths, and are jointed by ends which screw into one another, leaving a flush surface, until a tube of 200 feet has been formed. This length of tubing is then laid in the trench, and covered all around with a layer of concrete, which is allowed to set. This accomplished, the steel pipes, which only serve as a mandrel on which to form the concrete duct, are withdrawn by the application of steam, which is driven into them under pressure. The heat thus applied melts the preparation around the pipes, and as this also acts as a lubricant, the pipes can be withdrawn quickly and easily by winch and rope. As each 5-foot section of piping is withdrawn, it is unscrewed and coated again for further use. By this ingenious process a concrete conduit of perfectly symmetrical form is obtained for the accommodation of the cables. These are drawn into the duct in the usual manner, the lubricant that remains inside considerably facilitating the operation. More than 100,000 feet of cables have been laid in this manner in Poplar, the process having proved completely successful.

The results of some tests on hard solders for steel brazing made by the British National Physical Laboratory were published in the October 28, 1904, issue of *Engineering* (London), from which it appears that the presence of iron in small quantities and of lead of approximately, or over, one per cent, is detrimental to the strength and flushing quality of the solder. Spelter or solder made up of copper, 52.53; zinc, 45.46; lead, 1.35; and iron, 0.42, was found unsatisfactory for mild steel (0.3 to 0.35 carbon) brazing. With the proportions: copper, 63.19; zinc, 36.31; and lead, 0.65, the spelter was found to have

a fairly high melting range, good flushing quality (spreads well) and good tenacity, the strength of a brazed joint being over 9,500 pounds per square inch of brazed section. As the proportion of zinc to copper is increased, the temperature of melting decreases, giving a low range. Hence such spelters are bad for brazing steel, as the latter metal cannot be made sufficiently hot to get a perfect union. Hence the following result with copper, 49.76; zinc, 49.16; and lead, 0.98. The flushing was good, but the tenacity was low, falling to about 7,400 pounds per square inch of brazed section. The introduction of iron into spelters generally comes from the use of an iron rod for stirring the molten spelter in the process of manufacture, and the practice is one that should be avoided.

In regard to work of an intermittent character some one has said that the steam engine works by the day and the electric motor by the piece. In other words, the boiler burns coal all the time whether the engine runs or not, but expense with the electric motor is only incurred while it is actually running. This fact would seem to make the electric motor for some classes of contracting a source of power preferable to the donkey engine and boiler commonly used on such work. This of course applies to cities and districts where electric power from service mains is available, but when we consider the vast amount of excavating and similar work in large cities that requires power, it seems that the average contractor does not appreciate the full value of the electric motor as he should. There are of course difficulties in the way of using the "juice," and perhaps the electric companies themselves have not encouraged this demand. A writer in the *Western Electrician* says, in an article on the subject, that the contractor having to pump out an excavation generally uses two laborers to a pump, and although he may use arc or incandescent light at night to enable the work to be pushed hard and fast throughout the whole twenty-four hours, never seems to think of using a motor-driven pump for the job, thereby saving the laborers' pay. It might be added that cutting down expense for lighting, which would be largely unnecessary with the motor-driven pump, would largely compensate for the power required to drive the pump.

In an article upon pipes and joints for high pressure read by Mr. Franklin Riffle before the Technical Society of the Pacific Coast, May 27, 1904, a variety of pipe joints adapted to high pressure pipe lines was described. The simplest line pipe coupling for high-pressure service is a modified form of the standard pipe coupling, from which it differs in that the coupling is made longer and heavier. It is recessed for a short distance at the ends to the exact diameter of the outside of the pipe; thence it is threaded, the thread having a taper to the center of ¾ inch per foot to correspond to the standard taper of pipe thread. By recessing the ends of the coupling and making the ends of the coupling snugly fit the pipe, the liability of fracture through the thread is largely reduced, inasmuch as the coupling bears upon the pipe joint beyond the threaded portion. The writer puts special stress upon making the taper of the thread in the coupling exactly correspond to the taper of thread on the pipe in order to secure a tight joint, as this insures a perfect contact for every thread. We believe, however, that Professor Sweet advocates making the taper of a thread somewhat less than the taper of the hole, to compensate for the additional wear to which this part is subjected in screwing it home, and because of its thinner section, which causes it to compress more easily than the thicker parts. By making the taper of the pipe about ⅝ inch per foot, Professor Sweet calculates that, in average practice, the pipe and coupling will be in uniform contact throughout when screwed into place.

Plans for additional subways for New York have been proposed by Mr. William Barclay Parsons, and submitted by him to the Rapid Transit Commission, of which he is the chief engineer. These plans differ from any heretofore proposed and contemplate additional lines in Manhattan, the Bronx, and Brooklyn. A new line on the east side of New York is provided for, to run from the Battery to East One Hundred and Forty-ninth Street in the Bronx, with a two-storied subway in Lexington Avenue; a new line on the west side, from the Battery to Forty-second Street, where it is to connect with the present subway; a cross-town connecting line at Thirty-fourth Street, between Seventh and Park Avenues, and a diversion of the proposed Fourth Avenue line to Fort Hamilton in Brooklyn, to Hamilton Avenue, thence under the channel to Governor's Island and on to the Battery, in Manhattan, whence it is to run under Greenwich Street to connect at Barclay Street with a low level loop of the proposed new west side route.

The plan proposes for the Borough of the Bronx, an extension of the west side line from Kingsbridge to Van Cortlandt Park, and a lengthening of the present east side line from its terminus at One Hundred and Eightieth Street, under Bronx Park to the city line. It is also proposed to extend the elevated railway from One Hundred and Fifty-fifth Street, on the west side across the Harlem River, to Woodlawn, to extend the elevated lines in Brooklyn, and to build two additional tracks on the Second Avenue "L" line, in Manhattan, for express trains.

The cost of the proposed new lines, as estimated, would be $40,000,000 in Manhattan, and for subway extension in Brooklyn and the Bronx, $9,000,000.

CHARACTERISTICS OF BRONZES.

In speaking before the Franklin Institute on the "Physical Characteristics of Certain Bronzes for Steam Uses," as reported in the *Journal of the Franklin Institute* for January, S. L. Kneass stated that the copper-tin alloys in general vary from 5 to 24 parts by weight of copper to 1 of tin, with a small percentage of lead or zinc or of both. The true binary alloy is little used, because the addition of other metals, such as lead, zinc, nickel, phosphorus or aluminum to the copper and tin, adds useful qualities and reduces cost of machining. For example, a trace of zinc is used in a 5 to 1 mixture for certain kinds of spindle-bearings or sleeve nuts, producing a hard and brittle metal, machining with a short chip which flies from the tool with great force. It is somewhat difficult with this to get a smooth surface, but the bearing wears well under heavy pressures. A good hydraulic bronze is made of a ratio of 7 copper to 1 of tin, and a little more zinc. This has sufficiently high tensile strength, machines well, and runs solid in the mold.

The essential characteristics of a good steam metal are homogeneity, solidity, tensile strength, rigidity, facility for machining, fluidity in casting, and non-corrosiveness. Homogeneity is much more difficult to obtain in an alloy composed of copper, tin, lead and zinc than in a mixture of copper and tin alone. The rapidity of melting, temperature of pouring, and the condition of the mold, as well as the form and size of the section and rapidity of cooling, all have an influence on the homogeneity, although imperfect mixing is probably the chief cause of trouble in this respect. Tensile strength and rigidity depend upon the proportion of copper to tin and their preponderance over the lead and zinc, while the character of the chip is determined chiefly by the percentage of lead, and the fluidity by the zinc. The proper mixture for any purpose must be a compromise, with a tendency toward homogeneity and density.

Bronze castings in service are subjected to two serious deteriorating agencies, the attrition or wearing away due to the passage of water, sand, etc., over them, and the solvent action of the contained fluids in the casting. The more soluble metals in the bronze are apt to be dissolved by acidulous or alkaline elements in the alloy, causing porousness and possible leaks. The abrasive effect of water, sand, etc., is in some cases seen to be considerable. The jet of an injector may have a velocity of 800 feet per second, and a pressure against the walls of the tube of 80 to 100 pounds per square inch. Hydraulic valves made of bronze are often subjected to a pressure of 4,000 pounds per square inch, and the velocity of the water or oil through them may reach 2,400 feet per second during opening or closing. In such cases any defect in the bronze is sure to cause rapid deterioration in the efficiency of the device.

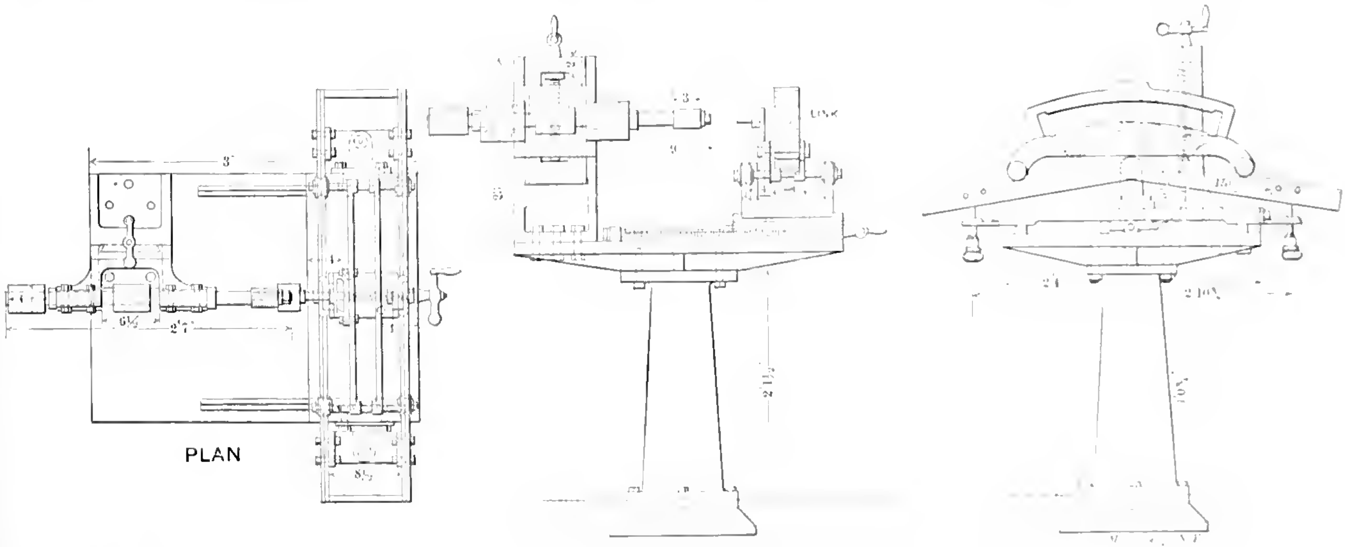
Careless mixing of the fluid metal before pouring is an ob-

vious cause in the variation of quality in bronzes. An extreme case was proved by specimens taken from castings poured from the top and bottom of a bail-pot without special stirring. Only a trace of lead was found in the specimens from the top and three times the required amount in those from the bottom, neither being fit to use.

The effect of rapid cooling is beneficial, increasing the density, reducing porosity and making the section more uniform. A casting poured in an iron mold should have a closer grain, higher tensile strength, and greater specific gravity than if poured in sand.

LINK GRINDING MACHINE.

In the November issue of the *Railway Master Mechanic* a link grinding machine was illustrated, which was designed by Mr. James F. DeVoy, and is now in use in the West Milwaukee shops of the Chicago, Milwaukee and St. Paul Railway. The machine is supported by a cast iron pedestal bolted to the floor, and the several moving parts rest upon a cast iron bedplate, which is secured to the supporting pedestal. The link is bolted to a pair of light brackets, so arranged as to constitute a carriage. This is carried on two pairs of rollers, one pair being located at each end. The rollers traverse a set of guides which are supported at the center, about which they may be rotated within narrow limits, and are adjustable at the outer ends by micrometer screws. These guides are carried upon an upper bedplate, which in turn is arranged to



Link Grinding Machine

slide transversely on guides which are cast to the principal bedplate. Transverse motion is given thereto by a crank handle and horizontal feed screw. The holes in the link brackets through which the link is bolted, are made oblong in order to fit the several sizes of links in service on the different classes of locomotives. When the link has been placed in position the roller guides are adjusted by the micrometer screws to obtain the exact radius desired for the link. The upper table is then moved transversely to such position that the emery wheel engages the surface of the link. The link bracket is then moved back and forth by hand, rolling up and down along the guides, the motion being such that the link is vibrated in an arc of a true circle. For grinding link blocks a small cast iron bracket is provided. This bracket, when in use, is bolted to the link bracket nearer the emery wheel stand, two holes being drilled in the nearer link bracket to coincide with the bolt holes in the link block bracket. The emery wheel is driven by a belt from the countershaft above and is so arranged that it may be raised and lowered by a hand crank and vertical feed screw. A noticeable feature of this machine is the small amount of space which it covers, as compared with other devices for the same work.

COMPARISONS AND NOTES ON PRIME MOVERS.

Abstract of Article by William McClellan, Ph D., Engineering News, December 29, 1904.

The relative standing of the chief types of prime movers is at present so unstable that a prominent engineer lately declared that he would not dare, at this time, to install a large steam engine plant, or even one of steam turbines, for fear that before he got it running he would wish he had put in gas engines. Nevertheless, in this country, there are some engineers who refuse to consider any type but the reciprocating steam engine. To sum up what may be said for the various types, considering plants of not less than 1,000 H. P., prime movers may first be classified as follows: *Steam:* (1) Engine, (2) Turbine. *Gas:* (3) Engine; (4) Turbine. *Oil:* (5) Engine, explosion type; (6) Engine, Diesel type. *Water:* (7) Turbine. Of these, only the first three are discussed, the others not being sufficiently developed.

A prime mover should be considered in regard to reliability, regulation, and cost, here arranged in their relative order of importance. The reliability of any machine depends upon proper design and proper operation. So far as design is concerned, all three types should be equally reliable. The steam turbine, owing to its small number of parts, small friction surface, and absence of reciprocating motion, should be extremely so, its one point of possible danger at present being the possibility of overheating high-speed bearings. The gas engine has overcome its earlier difficulties of design for parts having excessive pressures to withstand. The difficulty of ignition has been overcome by duplicate igniters and proper inspection, although the igniter will always be a source of trouble, and for this reason a practical gas turbine, or slow-burning type of engine will be sought for until it is found.

As to the question of proper operation, there is this to be said, that while but few have yet had experience with the gas engine, there is a small army of men who understand all the details of steam operations. An experienced steam engineer can tell by ear whether all is right or not with his engine; he knows a thousand makeshifts to help him out of tight places. Many of these will serve equally well with the gas engine, but more will have to be learned. The practical engineer cannot be taught in a day that clean gas is just as important as dry steam, and that cooling water is an absolute necessity in a gas engine, and not a mere help as it is in an engine-bearing. A gas engine installation is thoroughly reliable, but care should be exercised in the selection of the men, and they should not be left in entire charge of the engines until they are well educated. Many persons are claiming that a cheaper attendance will be possible with the gas engine. If by this they mean a smaller number of men, they are right, owing to the smaller number of auxiliaries; but if they mean less intelligent men they are mistaken.

It is more fair to consider the two plants rather than the engines alone. The steam plant consists of a boiler with a large number of joints under high pressure; a long line of piping under like pressure, and subject to extreme expansion strains, and a group of pumps, traps, condensers, valves, etc., with which it takes a man a long time to get acquainted. In the gas engine plant we have a producer and holder under little pressure; a low-pressure pipe line; no auxiliaries except a starting outfit and a very simple exhaust, a plant with

large possibilities for storage of power at low cost, and really so simple that in all gas engine discussions no attack has ever been made on any part of the plant except the engine.

Given proper operation, any one of the three types of plant is reliable and could be recommended for continuous service.

Regulation applies in two ways to prime movers: to speed of revolution, or simply "regulation," and to cyclical variation during a single revolution, or "variation." Steam engine contracts call for a regulation of 1.5 per cent and a maximum variation of 1¼ degrees in phase. Steam engines can regulate sufficiently well for the paralleling of alternators, the crucial test, as shown in daily practice. The steam turbine is capable of the very closest governing, and has in tests shown its superiority. The gas engine, receiving its energy not continuously, like the turbine, but in impulses, is more difficult to regulate.

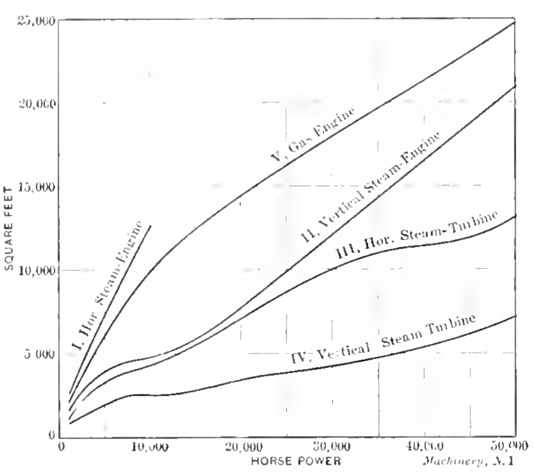


Fig. 1. Diagram of Floor-space Required for Different Kinds of Prime Movers, for Various Capacities of Plant.

There are four methods of gas engine governing, (1) the "hit or miss," (2) throttling, (3) impoverished charge, and (4) variation of explosion point. The first is unsatisfactory for large engines, and the third is but a modification of it, and is no more desirable. The fourth is uneconomical. Throttling, which does not have the objectionable features in gas engine as in steam engine work, will probably be the method generally adopted eventually.

In this country gas engines in large sizes have been built after three types: The three-cylinder single acting, four-cycle type, receiving energy two-thirds of every revolution; the two-cylinder single-acting two-cycle tandem type, receiving energy at every stroke, and the two-cylinder double-acting four-cycle tandem type, receiving energy at every stroke. Double engines are frequently built of the two latter types. An engine which receives energy as frequently as every two-thirds of a revolution can be governed well enough for any purpose, as has been shown in practice. Hence since the work is done satisfactorily by all three types, there is little room for argument on the score of regulation.

As to cost, it is of course impossible to approximate correctly in individual cases without special study of the conditions, but average figures can be given. Table I., herewith given, applies to the following plants: (1) A steam engine plant, consisting of a compound Corliss engine running condensing, without superheat, and supplied with steam by horizontal water-tube boilers with cast-steel headers; (2) a steam turbine plant under the same conditions; (3) a gas engine plant with horizontal gas engines and Taylor producers.

In discussing the various items, we come to consider relative amounts of space required for different types of plant. The curves here reproduced, as Fig. 1, are from a paper by E. H. Sniffen (Am. St. Ry. Assn. 1902). Curve III. is the Parsons steam turbine and curve IV. the Curtis. Curve V. is meant for the average gas engine.

A point to be considered in connection with this is that the boiler capacity is the same for engines and turbines, and the arrangement of boiler space, to go with the most economical spacing of the turbines, has to be considered. In Figs. 2, 3, and 4 is shown diagrammatically a plant of three 1,500 K. W. vertical turbines, with required boiler capacity, laid out in three different ways. Fig. 2 is the ordinary back-to-back method, which here is uneconomical unless the extra space is used for different purposes. In Fig. 3 the boilers are placed in two sections on the same level, and Fig. 4 shows a double decked arrangement. Engineers have seldom designed double

TABLE I. POWER PLANT COSTS.

First Cost, Dollars per Kilowatt.

	Steam Engine.	Steam Turbine.	Gas Engine.
Building and foundation	$12.00	$6.00	$10.00
Auxiliaries and piping..........	8.00	6.00	included in engine.
Engine and generator	32.00	30 00	74.00
Total.......................	52.00	42.00	84.00
Boiler room or producer shed (including pumps, heaters, piping, economizer and stack).........	12.00	12 00	included above
Boiler and stoker (erected)......	14.00	14.00	20.00
Total.......................	26.00	26.00	20 00
Grand total of first cost per kilowatt.........................	78.00	68.00	104.00

Operating Cost, Dollars per Kilowatt-year.

	Steam Engine.	Steam Turbine.	Gas Engine.
Fixed charges, 15% of cost.......	$11.70	$10.20	$15 60
Labor..........................	6.20	5.75	4.40
Oil............................	1.50	.60	1.80
Coal	14.60	14.60	7 30
Total of operating cost per kilowatt per year.................	34.00	31.15	29 10

Notes: Capacity of each plant, 4,500 KW. in three 1,500-KW. units.
Interest, depreciation and taxes, 15%.
One year = 7,300 hours (365 days of 20 hours).
Load, electric railway of 50% load-factor.
Cost of coal, $2.25 per ton of 2,240 lbs.
Two engine H.P. = one boiler H.P.

decked boiler houses, but why in a turbine installation there should be any objection to them is hard to see. The risk from explosion is almost nothing with water-tube boilers, and the piping is very direct. The only difficulty, coal and ash-handling, is not a great one. Conditions are about the same with horizontal turbines.

A comparison of the space required for boilers and for producers shows some interesting facts. The amount of space

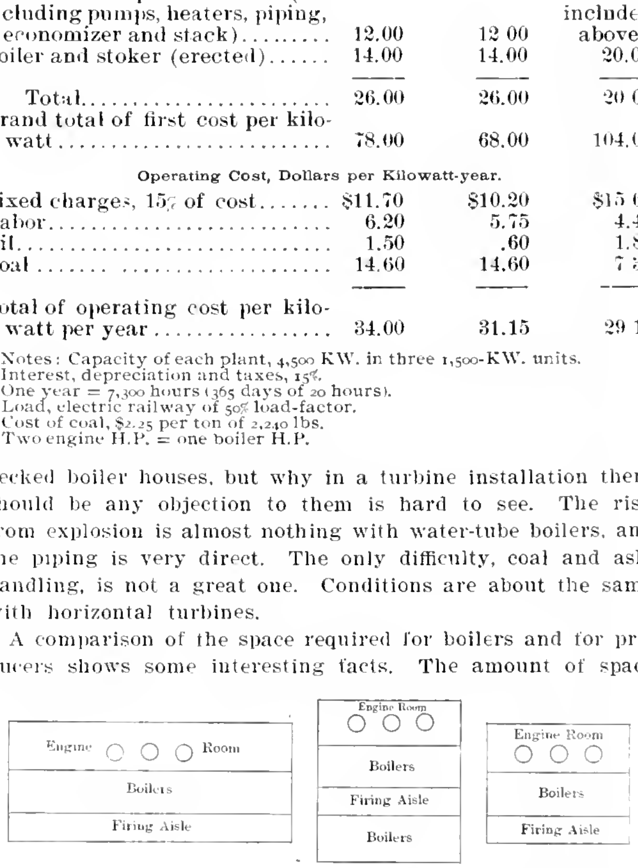


Fig.2 Fig.3 Fig.4

Machinery, N.Y.

Figs. 2, 3 and 4. Sketches showing three ways of Arranging a Power Station using Vertical Steam Turbines.

assumed for boilers in the table is an average of that required for several makes of the water-tube type, though the most efficient make of this type known to the author requires only 1.28 square feet total floor space, and occupies only 26 cubic feet per boiler H. P. In Table II. is given a summary of floor space required by various producer plants. This shows an average value of 1.7 square feet per engine H. P., which is about the same as required by the boilers.

TABLE II APPROXIMATE DIMENSIONS OF SPACE REQUIRED FOR PRODUCER AND HOLDER, FOR TAYLOR AND MOND GAS PRODUCER PLANTS.

Capacity.	Length. Taylor.	Length. Mond.	Width. Taylor-Mond.	Height. Taylor.	Height. Mond.
500 H.P.	42 ft	68 ft.	26 ft.	20 ft.	30 ft.
750 H.P.	45 ft.	70 ft.	28 ft.	25 ft.	35 ft.
1,000 H.P.	45 ft.	70 ft.	40 ft.	25 ft.	35 ft.
2 500 H.P-	50 ft.	80 ft.	80 ft.	25 ft	35 ft.
5,000 H.P.	50 ft.	90 ft.	155 ft.	25 ft.	40 ft.

As to the costs of engine and generator, the steam turbine should gain a little in the generator cost, owing to increased speed and reduction of weight. For years generator design has been governed by the demands of the Corliss engine. Most engineers hesitate about running this engine beyond 120 revolutions per minute. On the other hand turbo-generators run at speeds varying from 1,000 to 4,000 revolutions per minute.

The cost of gas engines is certainly excessive. Large en-

gines have been quoted at from \$55 to \$40 per H. P., f. o. b. works. This high cost is the only handicap the gas engine has at present; the loss here cuts down a large part of its gain in economy. The best steam engines of this size can be bought for about 7½ cents per pound. The gas engine gains, of course, in the absence of auxiliaries.

In the boiler room estimates are included all except coal storage and power handling. Power handling of coal will be found economical except in a few cases. As the capacity of the storage and conveyor plant need be only one-half for the gas plant what it is for the steam plant, there will be here a saving for the former. The figure quoted for the producer includes a conveyor to the top of the producers, and all auxiliaries necessary for delivery of gas to the engines.

As to operation and fixed charges, the latter are lumped at 15 per cent, being interest at 5 per cent, taxes at 2 per cent, and depreciation at 8 per cent. Depreciation on well-built gas engines should be about the same as for good steam engines. Depreciation on foundations should be figured the same as for the engines, as they are of no use after the engines have been removed. The gas plant gains in the labor item, on account of there being less coal to handle, and the absence of auxiliaries, etc. Our conditions are coal at 0.1 cent per pound, a year of 365 days of 20 hours each, and a 50 per cent load factor.

Coal consumption is assumed at 4 pounds per kilowatt hour for steam engines and turbines, and 2 pounds per kilowatt hour for gas engines. The best water rate the writer has seen recorded for a two-cylinder condensing engine with superheat is 10.17 pounds per I. H. P. or about 17 pounds per kilowatt hour. Nineteen pounds per kilowatt hour is, however, considered unusual and 25 pounds is probably average. So far the steam turbine has not done better, though whatever economy it has at the start it is likely to keep until it breaks down, since experience shows that there is nothing to wear except the bearing. It should be noted that the high values given above depend upon high vacuum, superheat, and very close attention. Theoretically, 27 inches of mercury is a very ordinary vacuum, but in a large number of stations that the writer has visited in the last few months the vacuum was seldom over 23 inches. The turbine seems to suffer more from poor vacuum than the steam engine.

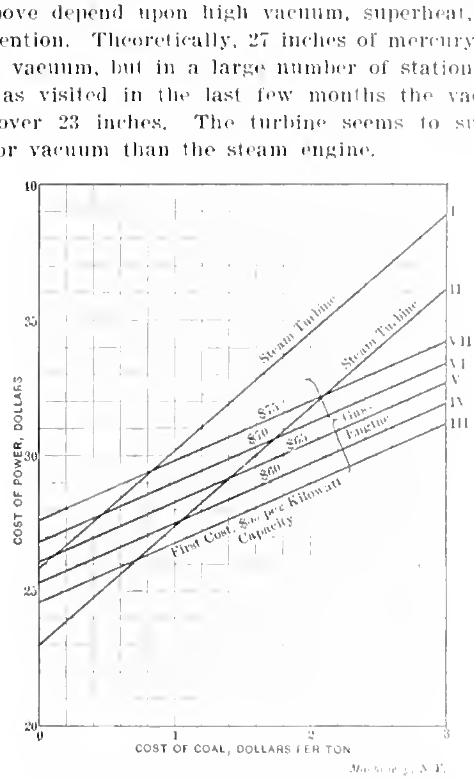


Fig. 5. Curves of Power Cost for Steam Engines, Steam Turbines, and Gas Engines, for Various Prices of Coal

In the above estimates, using conservative figures, there is a yearly saving, per installed kilowatt, of \$2.85 by the steam turbine and \$4.90 by the gas engine over the steam engine. The writer believes that from now on the decision will usually lie between the steam turbine and the gas engine for all units. The simplicity of the steam turbine is really the source of its many advantages. One has only to stop and think of the hundred adjustments, places to wear, etc., of the reciprocating engine to realize this.

We formerly heard much about the greater economy in the use of steam by means of the steam turbine, but later experiments have shown these statements to be unwarranted. However, owing to the absence of valves and of lubrication of the steam surfaces, the use of superheat is very easy. Also, as there is no oil in the exhaust, the water may be used over and over. When necessary, the time for manufacture and erection can be made very small. Regulation can be made almost perfect.

The reasons for the slow adoption of the gas engine in this country are the newness of the field, the divided interest of many manufacturers who are also engine-builders, and third the excessive first cost of the gas engine. As to the last, Fig. 5 is reproduced herewith, showing how changes in the value of coal and price of gas engines would affect the relative costs of power. Here ordinates represent cost of power in dollars per kilowatt year under the previous conditions. Curves III., IV., V., VI. and VII. are for the gas engine when the engine alone costs \$55, \$60, \$65, \$70, \$75, respectively, per kilowatt of capacity. The points at which the gas engine curves cross the steam turbine curve show the minimum prices of coal for which the gas engine is as economical as the turbine. At present prices of engines coal must cost at least \$2.15 per ton to justify installing gas engines on the score of economy.

In Europe the gas engine is regarded as entirely reliable, and is being used in all cases where it is economical. It is theoretically and practically much more efficient than any steam prime mover, the plant is remarkable for its simplicity and consequently the liability to shut down is greatly reduced. The plant has great possibilities of power storage at little cost. The producer is probably 10 per cent. more efficient than the steam boiler, and even more so if the condensation losses in pipes, traps, etc., be included. Indeed, a poorer quality of coal might be used in the producer for results equal to those of the boiler.

DESTRUCTIVE ACTION OF INTERNAL TUBE CLEANERS.

The Locomotive, October, 1904, p. 90.

There are numerous forms of boiler-tube cleaners upon the market at the present time which are actuated by power. Some of these are designed to clean the inner surfaces of the tubes of water-tube boilers, some to remove sooty deposits from the fire side of the tubes of fire-tube boilers, and some to remove scale from the outer surfaces of the tubes of fire-tube boilers. These last act by striking a succession of blows against the interior of the tube, and thus jar the scale off from the outside. In the present article no reference will be made to those forms in which the deposits in fire-tubes are blown or sucked out by blasts of air or steam, nor to those by which the soot or scale is removed by the action of scrapers that are merely run through the tubes, except in so far as our remarks upon the danger of blowing steam through a cold boiler tube may be applicable to them. What is said will be mainly confined to those forms in which the apparatus employed communicates to the tube that is being cleaned a series of shocks of greater or less severity, either by directly hammering against the tube or the scale, or by the rapid rotation of a cutter or other revolving device which is corrugated or otherwise irregular in shape, and which strikes its blows in virtue of that irregular shape, the rotation, and the centrifugal force by which it is urged out against the tube.

The inspectors of the Hartford Steam Boiler Inspection and Insurance Company have made numerous reports of serious damage being done to boilers by cleaners of these types, and as the use of such cleaners is becoming increasingly common, the attention of steam users is called to the dangers that are incident to them, when they are improperly handled. These power cleaners are not condemned wholesale, because many of them give very good results when used judiciously and intelligently; but precautions must be taken in the use of such appliances, in order that the good results that they are capable of yielding may be realized, while the bad results may be avoided with corresponding certainty.

The reality of the danger from power tube cleaners is sufficiently illustrated by Figs. 1, 2, and 3, which are taken from actual specimens removed from a boiler upon which a power cleaner had been used. The particular cleaner that was em

ployed in this case is one that hammers against the inside of the tube of a fire-tube boiler, the jar that is thereby communicated to the tube being supposed to rattle the scale off from the outside of the tube. In the instance now under discussion, two boilers of a certain plant had been cleaned in this way, and when they were again put in service seven of the tubes collapsed in one of the boilers when the pressure reached 90 pounds. The inspector of the Hartford Steam Boiler Inspection and Insurance Company was summoned at once, and upon visiting the plant he found that, in addition to the seven tubes which had collapsed, four others were strongly oval in shape, so that they had to be removed. Fig. 1 shows a portion of

Fig. 1. Portion of Collapsed Tube.

one of the collapsed tubes, precisely as it was removed from the boiler; the flattened part extending to within nine inches of the end of the tube, or over the exact distance traversed by the cleaner. Fig. 2 is an engraving of a section of one of the other tubes, which had become oval from the action of the cleaner, but which had not collapsed. The cleaner, instead of being constantly rotated and moved along the length of the tube, had been allowed to remain in one position for a short time, so that the hammer had pounded against the tube in one spot, which is indicated by the bright area on the inside of the tube. The result was that the tube was forced out into an oval shape, the greatest bulge coming opposite the bright spot. The actual deformation of the tube not being very evident to the eye in Fig. 2, an outline cut is given in Fig. 3 that exhibits it more clearly. The black outline in this cut was derived by placing the section of tube shown in Fig. 2 endwise against a sheet of paper, and drawing its inner and outer contours with a pencil, the space between the two lines so obtained being then

Fig. 2. Section of Tube Deformed by Action of Cleaner.

filled in with ink, to represent the thickness of the tube. The actual, deformed contour being recorded in this way, dotted circles were next drawn, to show the original form from which the tube had been distorted by the action of the hammer. It is only fair to add that in this case micrometric measurements of the thickness of the affected tubes showed that they had been slightly thinned by the wear incident to ordinary use. The thinning was in no case great enough to render the tubes unserviceable, however, nor was it greater than would be found in the general run of boilers that have been a few years in service.

The cumulative effect of the blows of a power cleaner of this type, when the cleaner is permitted to remain stationary for a short time, is illustrated not only by the distortion of tubes, but also by their actual splitting, in severe cases. One inspector, for example, has recently reported a case in which three tubes were split in this way in one boiler, from a single application of the tool. In this case the affected tubes were previously in excellent condition, and not sensibly thinned by wear nor by corrosion. The continued and severe action of a power tube cleaner may also actually stretch the tubes longitudinally, so as to loosen them in the heads, and cause leakage and loss of holding power. In one instance, for example, an inspector found that a number of tubes in a boiler were projecting through the tube sheet at one of the heads by as much as 1/8 inch to 3-16 inch, although they had been originally well beaded down to the head. As these tubes were in good condition at the previous inspection, and there was no visible reason for their elongation, the inspector made inquiries for the purpose of discovering the cause of the trouble, and learned from the engineer that a power tube cleaner had been passed through all of the tubes, and that the extension of the tubes had immediately followed its application.

These defects are not confined to cleaners which strike against the inner surfaces of the tubes of fire-tube boilers, but

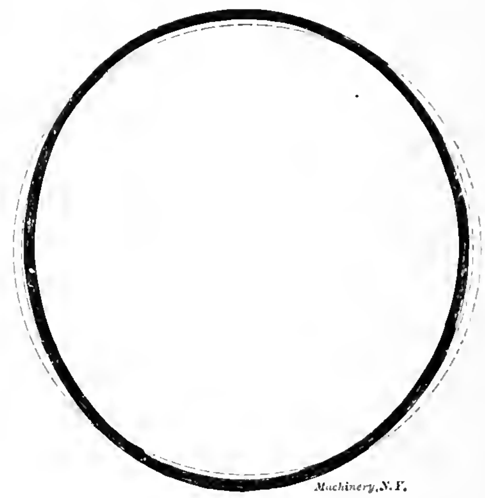


Fig. 3. Showing Deformation of Tube.

are liable to be observed in any type of power cleaner which operates by repeated concussion upon the tube, or upon such scale as may be attached to the tube. Numerous cases have been reported in which water-tube boilers have been badly damaged by the action of cleaners that have been run through their tubes for the purpose of cutting out the scale upon their inner surfaces. In one such report the inspector says: "They had worked on ten tubes in the bottom row of boiler No. 1, but they soon found that one of the headers was cracked, and upon examination it was discovered that every tube into which the cleaner had been passed had crept forward through the front head by from 1-32 inch to 1/4 inch. I could hardly believe this, but I saw it with my own eyes, and know it to be a fact. The cracking of the header had been due to this cause, and I did not think that it would be safe to proceed any further with such an apparatus. I suggested to the management that possibly they did not understand how to operate the machine, and I emphasized to them the necessity of taking extreme care if they were proposing to continue its use, as it would never do to put such a stress upon these headers as they had evidently been subjected to."

In another case of a similar sort, where a water-tube boiler was being cleaned, "the cleaner was being used under a steam pressure of 100 pounds, and every blow of the hammer left its impression by a dent in the tube." In this instance the pressure used to operate the tool was undoubtedly very excessive. The pressure should certainly not exceed 50 pounds, and we are of the opinion that 20 pounds is all that ought to be employed. If steam of this tension is not directly available, a reducing valve should be employed, so that the actual pressure furnished to the tool could not exceed a reasonable limit, such as 20 or 30 pounds. Any tube that is scaled so badly that it cannot be cleaned by a pressure of this magnitude should be

removed and replaced by a new one. Leakage around the tube ends is a commonly-reported result of the use of mechanical cleaners, the tubes being either actually elongated by the blows, as already pointed out, or merely loosened in the heads or headers by the constant succession of shocks to which they are subjected. The extension of the metal is sometimes made evident by the sagging of the tubes, and one report tells of a case in which the tubes were so stretched that when the boiler was again put into service, certain of them bent up or down until they came in contact with tubes in adjoining rows.

In the case of cleaners whose action involves the discharge of steam into or through the tubes, leakage around the tube-ends, or the actual extension of the tubes through the heads or headers, is liable to be caused by the direct expansion of the tubes, due to the heating effect of the steam. If the tubes and the shell were all heated at the same time and by the same amount, there would be no stresses introduced by the heating; the danger being, not from the heat itself, but from the stresses caused by the fact that the expansion is local, and practically confined to tho tube that is being cleaned. It is easy to see that if one tube grows longer from thermal expansion, while the rest of the boiler retains the dimensions that correspond to its lower temperature, there must be a stress of some magnitude thrown upon the tube and upon the heads or headers into which it is secured. The rise of temperature of a tube that is being cleaned by such a device is often considerable, for if a tube is at all foul with scale, it may require twenty minutes or so to bring it into proper condition. We believe that some (and perhaps all) of the manufacturers of tools of this kind, being alive to the danger of starting the tubes by local heating, recommend that the boiler itself bo heated up, before setting the cleaner at work, so that the effects of the subsequent warming from the action of the cleaner may be minimized. This practice appears to be of doubtful wisdom. In the case of a water-tube boiler the only method of heating the boiler that appears to be at all feasible is to build a light fire under it, while it is dry. If the fire is handled carefully and by a man of good judgment, the boiler may perhaps be warmed in this way sufficiently to prevent subsequent injury from unequal expansion, and yet without being itself injured by the direct action of the fire; but we should hesitate to recommend such a measure for general employment, because we should fear that the average attendant could not be depended upon to always strike the somewhat nice medium at which the warming of the boiler is effective, while the boiler itself is not overheated in any part by the fire. Moreover, the remedy would hardly be effective in any case, unless tho slow fire were maintained during the entire time that the tubes are being cleaned. If the boiler were heated up only at the outset, for example, then it is evident that if from ten to twenty minutes are spent upon each tube, the majority of the tubes in the boiler would have ample time to cool down before the cleaner reached them. If, on the other hand, the slow fire were maintained during the entire time of cleaning, there would be a correspondingly greater danger that at some part of this period the fire would either become so light as to be ineffective, or so heavy as to overheat some part of the boiler. It is far better and safer to avoid altogether the discharge of steam into a cold tube, and to operate the cleaner with compressed air. This is sometimes inconvenient, but it is better to go to a little trouble and expense, rather than to take chances of injuring the boilers. Of course it is unnecessary to say that there is no objection to the use of steam in those forms of power cleaners which are operated by motors external to the tube, and in which the exhaust does not enter the tube.

In review of what has been said, let it be stated that when power tube cleaners are used, they should be kept in motion, so that they cannot strike a succession of blows against any one part of the tube; 2, they should be operated by a pressure not exceeding 20 pounds, or, at the most, 30 pounds per square inch; 3, steam should not be permitted to blow through the tubes of a cold boiler for a sufficient time to sensibly heat the tubes; 4, compressed air should be used to operate tube cleaners, unless the motive power is entirely external to the tube; 5, in any case the boiler should be carefully watched during and after the application of a power cleaner, especially around the ends of the tubes, and on the headers; and at the first sign of distress of any kind, the use of the cleaner should be promptly discontinued; 6, lastly, a power cleaner should never be put in charge of any attendant save one upon whose judgment and skill the owner of the boiler can implicitly rely.

COST OF POWER IN STREET RAILWAY SERVICE.

Sibley Journal, December, 1904.

During the past twelve years the students of the graduating class of Cornell University have made a number of tests of street railway plants under the direction of Prof. R. C. Carpenter. Abstracts have been made of graduating theses describing these various plants, which are embodied in the shape of tables, as follows: Table I. Summary of Tests of Simple Non-Condensing Slide Valve Engines; Table II. Summary of Results of Tests of Simple Non-Condensing Corliss Engines; Table III. Summary of Results of Tests of Compound Non-Condensing Engines; Table IV. Summary of Tests of Compound Condensing Slide Valve Engines; Table V. Summary of Tests of Compound Condensing Corliss, Greene, McIntosh & Seymour and Similar Valve Motions; Table VI. Summary of Average Results; Table VII. Cost of a 1,000 Horse Power Plant (engines in units of 500 horse power each), and Table VIII. Fuel and Interest Charges for Different Classes of Engines per Horse Power.

TABLE VI SUMMARY OF AVERAGE RESULTS.

Class of Engines.	Steam per I. H. P. pounds	Coal per I. H. P. pounds	Proportional Value of Engines.	Probable Coal per K. W. H. pounds
(A) Non-condensing.				
Slide valve, simple; average......	34.3	4.63	53.1	6.90
Best result	31.6	4.61	.....	.
Corliss simple, average	28.3	3.45	64.5	5.65
Best result	26.9	3.01		...
Slide valve, compound, average.	30.37	4.17	60.2	6.12
(B) Condensing.				
Slide valve, compound, average.	22.7	3.25	80.5	4.57
Best result	16.7	2.40	..	3.60
Corliss compound, average.......	18.2	2.36	100	3.64
Best result	14.5	1.80	...	2.70

Tables VI. and VII. giving a summary of results and the cost of a 1,000-horse-power plant are reproduced herewith. In Table VI. a column appears giving the proportional value of the engine on the basis of coal consumption with a Corliss compound condensing engine placed at 100. A column giving the probable coal consumption per kilowatt hour is also appended.

Cost of Various Plants.

The cost of engines, boilers, etc., varies somewhat with the supply and demand, and as prices of materials change. The prices given in Table VII. for engines are in accordance with bids which Prof. Carpenter has recently received for engines of approximately 500 horse power each. The price of water tube boilers will vary with the kind selected, when erected on foundations, from about \$10 to \$16 per boiler horse power. For the sake of comparison he has assumed in Table VII. that the boiler costs \$12 per boiler horse power.

Table VI. shows that the steam consumption varies for the different classes of engines tested, from 34.3 pounds per indicated horse power per hour to 14.5 pounds as the best results obtained, or to 18.2 pounds as the average result obtained with the best class of engines. From this it is evident that the capacity of boilers required for steam may be reduced as the quality of the engine is improved and this in a measure tends to equalize the cost of installation.

Table VII. does not include the expense of a relay boiler, which should generally be provided. The cost of electrical generator, switchboard and station wiring approximates at the present time very close to \$22 per indicated horse power, or \$33 per kilowatt.

No figures at the present time are available for steam tur-

bines in railway use, but the economy from the best figures obtainable would seem to be about the mean of the results obtained with the slide valve and Corliss compound. The present cost of a 400-kilowatt turbo-generator with switchboard, foundation and erection, very closely approximates $20,000.

The cost of power house and real estate varies largely with the conditions. The cost of chimneys varies from $2 to $5 per horse power, depending upon the character, as to whether steel or brick. The cost of economizer, which has not been considered previously, averages very nearly $5 per boiler horse power. To all estimates cited above an amount should be added for contingencies, which for safety should not be less than 10 per cent.

TABLE VII. COST OF 1000 H P. PLANT—(ENGINES IN TWO UNITS OF 500 H. P. EACH.)

	Boiler H.P. required per Engine H. P.	Required Cost per Horse Power					Cost for 1000 H. P. Plant.
		Engine.	Boiler.	Pumps, Condensers and Heaters.	Piping and Foundations.	Total per I. H. P.	
Non-Condensing Engines.							
Simple slide valve.	1.135	$ 8.00	$13.60	$2 00	$6.00	$29.60	$29,600
Simple Corliss.....	0.933	12.00	11.20	2.00	6.50	31.70	31 700
Comp. slide valve .	1.00	11.00	12.00	2.00	7.00	32.00	32,000
Condensing Engines.							
Comp. slide valve. ·	0 75	11.00	9.00	4.00	7.50	31.50	31,500
Compound Corliss. ·	0.602	16 00	7.25	4.00	8.00	35.25	35,250

Table VIII. (not shown) is calculated for showing the yearly costs of operating power plants containing the different classes of engines. In this, interest is taken as 5 per cent and depreciation is assumed as 10 per cent. Fuel is calculated at $2 per ton, oil and waste are assumed to cost forty cents per year per horse power for each cylinder and each generator, an amount which experience has shown to be reasonable. Labor is calculated on the basis that a fireman is able to handle one ton of coal per hour and will work nine hours per day at a yearly cost of $600; when the coal exceeds one ton per hour by a small fraction an additional helper will be needed at an additional cost of $400 per year. The engine room force in all cases is assumed to be the same for all plants of 1,000 engine horse power, and is to consist of chief engineer at a salary of $1,200 per year, assistant engineer at a salary of $900 per year, and two oilers at a salary of $600 per year each, making a total cost of $3,300 for salaries in engine room. The wages for firing per year for 1,000 horse power, range from $3,200 (4 firemen, 2 helpers) for simple slide-valve non-condensing, down to $1,600 (2 firemen, 1 helper) for compound condensing Corliss of the best construction. The yearly fuel and interest charges per horse power range from $42.16 down to $23.20.

MANUFACTURE OF CHAIN.

The Iron Age, January 5, 1905.

Writing of the manufacture of chain, in *The Iron Age*, L. B. Powell calls attention to the importance of the chain-making industry, and the slight extent to which its processes are generally known. The manufacture of chain is divided into two classes: hand-made and machine-made.

A machine made chain covers sizes ranging from 3-16 to 1¼ inches, inclusive, and is made from open hearth steel in sizes up to 9-16 inch, and from ⅝ inch up is made from a common grade of iron. The principal steps in its manufacture are the winding of the links, cutting the links, and welding. The link-winding machine consists of a horizontal shaft about four feet long, driven by a belt and pulley attached at one end, while on the other end of the shaft is attached a mandrel over which the iron bar or steel stock is to be wound. The mandrel varies in size with that of the link to be formed, the outside dimensions of the mandrel being the inside dimensions of the link. Directly over the mandrel, and pressed tightly thereon by a powerful spring, is a steel guide wheel, grooved to carry the wire. The wire is fastened in the mandrel, the machine started, and the wire wound in a spiral of links, owing to the tight pressure of the guide wheel. When the spiral has reached the proper length, about 6 feet, the winder is stopped, and the spiral cut from the rest of the coil.

The spiral is next cut into links. This is done in a machine having a fixed blade for the base of the cutter, and a movable upper cutter, reciprocating up and down in a slide, being operated by belt and pulley. The spirals in being fed into the cutter are held in such a manner that the stock is cut at an angle of sixty degrees with the diameter of the rod. Each cut releases one link, the ends of which are cut scarfed, ready for closing. These links are now heated to a welding heat by either gas or coke fires, the former being the quicker and cheaper and the latter the more reliable. On being heated the links are linked into each other and the scarfed ends welded together by blows from a power hammer and taps from a hand hammer to give the material the proper working.

Hand-made chain is also known as "off the rod" chain and "dolly" chain. The iron for each link is cut off the rod and bent into shape hot, at the fire. After the weld is made, the joint is smoothed into shape by means of hammer blows on the dolly, which rests on the top of the link. The links are bent into shape on the anvil, and the ends scarfed by hand. For sizes of chain up to ⅞ inch, the chain-maker uses a kicker, which is a dolly hinged on the back of the anvil and having a treadle, so that it may be operated by foot pressure. All hand-made chain is made with coke fires.

Stud cable chain is a type of chain in which a cast iron stud, having its ends hollowed out to fit the sides of the link, is placed in the center of the link. The sides of the link are then narrowed to hold the stud firmly in place. This increases the tensile strength of the chain 50 per cent, and prevents its being bent out of shape.

Chains are tested on tensile testing machines in all chain manufacturing plants. Even when proved to be of the best material, however, the fibrous condition of the metal of a chain subjected to constant use and possible extremes of temperature is likely to change to a crystalline structure. This is known as the "tiring" of the metal, and is very dangerous. To obviate it, the chain should be annealed at least twice a year, by subjecting it to a uniform heat in a furnace, but never above a red heat. After remaining in the furnace for about four hours, at a red heat, the chain should be cooled gradually in a bath of sand. The chain should then be inspected for worn links, and given an oil bath.

The United States produces every year about 50,000 tons of chain, all for domestic consumption.

* * *

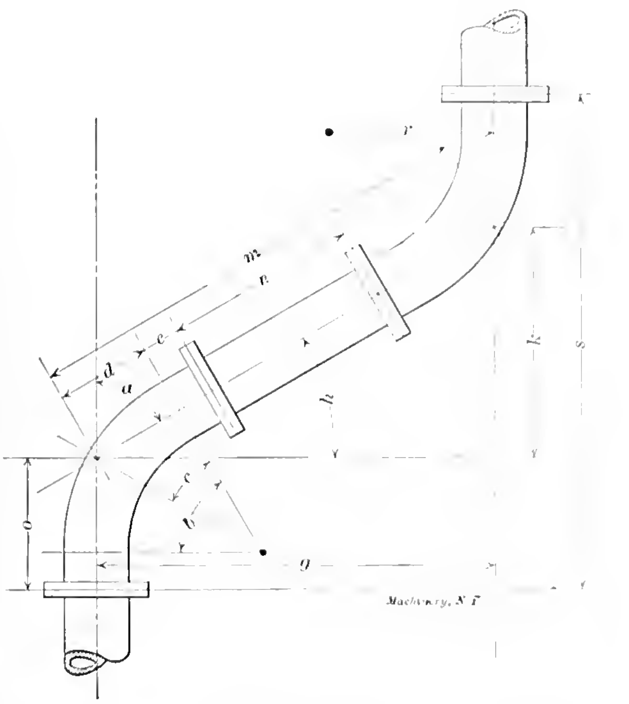
The United States consul general at Marseilles, France, says that notwithstanding official encouragement the alcohol motor and carbureter remains to-day incompletely developed, and the sale of alcohol motors is unimportant. Probably a hundred petroleum or gas motors are sold in France to one alcohol motor, and this he attributes to three reasons: 1, the high cost of alcohol; 2, the greater consumption per horse power hour than of either petroleum or gas; 3, the difficulties arising from oxidation. It appears from the report that the carbureter is not as efficient as an atomizer for the alcohol motor: a public competition with a 6-horse power motor showed the fuel consumed to be 0.904 pound per horse power hour with an atomizer as against 1.274 pounds per hour with the most popular carbureter in use in France. The trouble from oxidation which affects plugs, pistons, piston rings, etc., where alcohol is used, is serious unless care is taken to run the motor with gasoline during the last moments of use. It might be added that other experimenters have found a mixture of gasoline and alcohol to be more economical than the pure alcohol alone.

* * *

Errata: In the data sheet published with the January number, subject, Pipe and Pipe Threads—the decimal point was omitted in two of the formulas. For value of E read: E = perfect thread = $(4.8 + 0.8A)P$; and for height of thread read: Height of thread $= .8\,\frac{1}{N}$.

METHOD OF FINDING DISTANCE BETWEEN TWO ELLS CONNECTING TWO PARALLEL LINES OF PIPE.

The article herewith was submitted to us by Mr. Franklin H. Smith, Niagara Falls, N. Y., who, having recently had a problem in piping to meet and solve, has sent us the results of his work in the hope that it may benefit others engaged in the same work. The problem was to find the distance between two ells connecting two lines of pipe running parallel, to which the solution is as follows:



Illustrating Method of Finding Distance between Two Ells Connecting two Parallel Lines of Pipe.

Referring to the sketch, the angle $b =$ angle $a =$ angle of given ell.

Angle $c = \frac{b}{2}$

$d =$ radius r of the ell multiplied by constant for angle c for given ell, taken from Table I.

TABLE I. CONSTANTS FOR ANGLES c AND h.

Ell.	Constant—Angle h.	Constant—Angle c.
$5\frac{5}{8}°$	10.15320	.04913
$11\frac{1}{4}°$	5.02734	.09849
$22\frac{1}{2}°$	2.41421	.19891
45°	1.00000	.41421
60°	.57735	.57735
90°	.00000	1.00000

$e =$ distance to face of flange.

$g =$ distance between centers of parallel lines of pipe.

Angle $h =$ angle of 90 degrees minus angle a.

$k = g$ multiplied by constant for angle h, taken from Table I, for given ell. From whence

$m = \sqrt{K^2 + g^2}$. From whence

TABLE II.

Size of Pipe.	Allowance.	Size of Pipe.	Allowance.
$\frac{1}{2}$"	$\frac{3}{4}$"	3	$2\frac{1}{2}$
$\frac{3}{4}$"	1"	4"	$2\frac{3}{4}$
1"	$1\frac{1}{8}$"	$4\frac{1}{2}$	3
$1\frac{1}{4}$"	$1\frac{1}{4}$"	5	$3\frac{1}{2}$
$1\frac{1}{2}$"	$1\frac{1}{2}$"	6	4
2"	$1\frac{3}{4}$"	7	$4\frac{1}{2}$
$2\frac{1}{2}$"	$2\frac{1}{8}$"	8	$5\frac{1}{2}$

$n = m - 2(d + e) =$ distance sought, or the distance between the faces of the flanges of the ells.

$o = d - e =$ distance from center of ell to face of flange.

$s = k + 2o =$ distance between faces of pipe flanges parallel to pipe line centers.

In practice the length, n, must be shortened enough to place a gasket at each end. If the pipe is threaded instead of flanged, twice the length of the enclosed threaded part on either end must be added to n. Lengths of the enclosed threaded part, or allowance, for different sizes of pipe are given in Table II.

* * *

THE THREE M'S.

The firm of Manning, Maxwell & Moore, familiarly known in the trade as the three M's, is a noteworthy one. Established in 1873 as H. S. Manning & Co., which title was changed in 1881 to Manning, Maxwell & Moore, the growth of the business has been steady and constant until it is now one of the largest of its kind in the world, with branches in Chicago, Cleveland, St. Louis, Pittsburg, Boston and Philadelphia; owning and controlling the Ashcroft Mfg. Co., Consolidated Safety Valve Co., Hayden & Derby Co., Hancock Inspirator Co. and the Shaw Electric Crane Co. On the death of Mr. Maxwell, one of the original partners, some years ago, his interest was taken up by his associates; and the occasion of this notice is the retirement of Mr. Henry S. Manning from the cares of business, and the sale of his interest in the firm and its allied companies

Charles A. Moore

to Mr. Chas. A. Moore, the sale having been arranged entirely by the two men principally interested, after a partnership of thirty-two years, without taking an inventory.

Mr. Moore is one of the most widely known men in the machinery trade, but his acquaintance is not limited to that field, as he also has a wide interest in railway, social and political circles. President McKinley and Senator Hanna were among his personal friends, and it is said that the former offered him a position in the Cabinet at his first election. Mr. Moore is a man of strong individuality and great energy; and while credit should be given to Mr. Manning's business ability and to the almost unlimited financial backing of his associates, the success of the firm is largely due to Mr. Moore's individual efforts. He has many other interests and belongs to a large number of well-known business and social organizations.

* * *

A scheme that is sometimes used for locating pounds and knocks in high-speed engines is to rest a light stick of wood held between the teeth upon various parts of the engine, until the seat of the trouble is discovered. This, of course, only applies to the stationary parts, as there are very few who could wiggle their heads fast enough to follow the crosshead of the average engine!

THE AUTOMOBILE SHOW.

The annual Automobile Show held in Madison Square Garden, New York, from January 11 to 21 inclusive, was probably the most successful event of the kind that has been held in this country in the history of the automobile business, both in the matter of exhibits and the attendance. Large throngs of interested spectators were in attendance, and sales were heavy. A large number of machines, priced from $375 up to five figures were exhibited, and supplies and sundries in great variety. Although the majority of machines exhibited were purely for pleasure or racing, there was an appreciable gain in the number of motor trucks and delivery cars, showing that some builders are paying more serious attention to the utilitarian possibilities of the automobile. The main floor of the garden was crowded with cars mostly of the heavy tonneau type, and the basement exhibit was an extensive show in itself. The first and second galleries were occupied by the exhibitors of automobile supplies, speed devices, tires, wheels, speed changers, lamps, tools, and a thousand-and-one other things for which the trade has been found a good market. As an illustration of the variety we note among the exhibitors the Wm. Cramp & Sons Ship & Engine Building Co., who showed a line of manganese-bronze castings which has found considerable favor in the construction of automobiles. One of the striking castings exhibited by this concern was a 10-spoke manganese-bronze wheel center, the hub and spokes one casting and the spokes cored their entire length. Since this metal is guaranteed to have a tensile strength of 65,000 pounds per square inch, and an elastic limit of 30,000 pounds, it apparently has qualities which recommend it highly for the severe service to which it must be subjected in motor trucks and high-speed cars.

A number of novelties and speed-changing mechanisms were exhibited, one being the Shattuck device which was illustrated and described in MACHINERY, September, 1901. As will be remembered by those who saw this description, a gear cone is split longitudinally so that one-half can slide lengthwise upon the other half, thereby bringing the halves of adjacent gears in the same plane. The object of this movement is to change the meshing pinion from one step to the next without shock. However successful this device may be in actual use, the model worked very smoothly and attracted an interested crowd of spectators whenever it was shown in motion.

A number of the exhibitors showed chassis, that is, the frames, engines, and wheels, of their machines mounted over plate-glass mirrors, the reflection of which made the under side of the mechanism plainly visible from above. Some of these chassis were handsome specimens of work, the frames and all parts being polished steel with evidence of much hand work on the finish, but in many the complexity of mechanism would lead to the prediction that more or less trouble would be found in the care and operation. Perhaps the simplest machines of the tonneau type exhibited were the Northern automobiles. The engine is of the double opposed-cylinder type, the cylinders being mounted in a transverse inclined plane, and the crankshaft connected to the rear axle by bevel gears through an intermediate longitudinal shaft. This construction displaces the chain, and is finding favor with many automobile builders. It requires the use of universal couplings, and the result is that a variety of these interesting devices of variant and possibly of improved form were exhibited by manufacturers making them a specialty. Among the specialties were numerous oiling devices, some of the positive type which from a single reservoir distribute the oil to the various bearings of the engine. One of the inventions in this line is the Mason-Kipp valveless oil pump, in which the pistons or plungers are operated by eccentrics mounted on a shaft so that the eccentric twists or "wobbles" as it rotates, thus giving the piston a twisting and reciprocating action at the same time. In this way a longitudinal slot in the pump plunger covers and uncovers the opening leading to the delivery tube, and thus it acts as a valve as well as a piston. Perhaps as interesting an exhibit from a structural point of view as any was that of the Shelby Steel Tube Co., who showed a table top consisting of 3,500 pieces of their cold-drawn, seamless steel tubing set on end beneath a plate glass cover so as to show the cross sections. These sections of tubes are of great variety of shape—round, square, hexagon, oval, rectangular, etc.—and were arranged in an attractive geometrical design, which not only caught the eye, but gave a graphic idea of the variety of shapes in steel tubing now evolved for the constructor.

Several makes of speedometers were shown which indicate in direct readings the speed at which the machine is traveling. One of these, made by the Webb Company, is a geared rotary vacuum pump, which draws air against a vertical aluminum piston, weighing about six grains, and causes same to rise and indicate the reading on a vertical scale. As the piston rises, the chamber or cylinder enclosing it enlarges, being tapered with the large end up, which lets more and more air draw by it, thus putting it in balance for whatever speed the pump is driven at.

A freak, which, if it fulfills the promises of the inventor, should be popular in winter in those sections where snow is plentiful, is a motor sleigh. This machine propels itself by a kicking arrangement similar to that of a hay tedder. The inventor in defending his device from the aspersion of those inclined to ridicule, says that the average American citizen has a religious horror of being regarded as a crank, and it was this sort of spirit that drove Hiram Maxim, the inventor of the Maxim gun, to England. Whether or not he is entitled to rank with Maxim as an inventor, it appears that he has contributed to the amusement of the crowd, and for this much can be forgiven.

A novelty in tire-patching devices was shown in the shape of an unvulcanized patch of rubber, which is applied to a punctured inner tube with cement in the ordinary way. Being in the raw or unvulcanized state, it adheres more closely than treated rubber, and to make the patch permanent the inventor depends upon the heat generated in the tire to vulcanize the patch. As is well known, when running at considerable speed the tires of automobiles become appreciably warm or even hot, but whether the heat thus generated would be sufficient in all cases to vulcanize a patch to the inner tube seems somewhat doubtful. It certainly should not where speed regulations are enforced.

Many other schemes were shown, one being a horn which is blown with the exhaust by opening a by-pass valve with the foot; another scheme was a device for storing power to start the engine and save cranking. A spring is wound up by the engine while running and held by a clutch so that it may be released when the engine is to be started again; and so on. Surely the automobile industry is reaching large proportions, and the ultimate displacement of the horse seems nearer than ever before, although it is still so remote that it will be many years, we imagine, before he becomes so scarce in cities as to be a curiosity.

* * *

The Polytechnic Institute of Brooklyn has instituted a series of evening lectures for the members of its senior classes in Mechanical Engineering, this course to be open to outsiders upon payment of a small fee. Each lecture is two hours in length and will be illustrated by lantern slides and drawings. The following is a summary of the courses offered for the remainder of the year:

Eight lectures by William J. Baldwin, Consulting Professor of Thermal Engineering, on heating and ventilating systems in large buildings.

Six lectures by Reginald P. Bolton, Consulting Professor of Mechanical Installations, on mechanical installations in tall buildings.

Two lectures by Walter B. Snow, Consulting Professor of Aerodynamics, on mechanical draft.

Two lectures by H. H. Stock, Consulting Professor of Commercial Fuels, on coal.

Four lectures by Gardner T. Voorhees, Consulting Professor of Refrigeration, on refrigeration and cold storage.

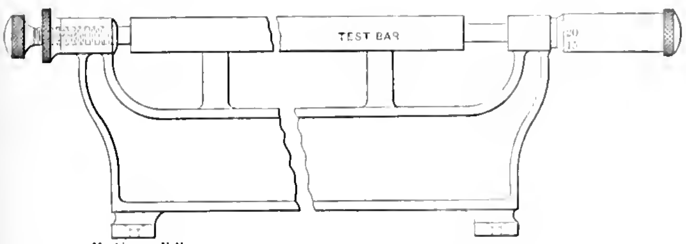
Similar courses are offered in Electrical and Civil Engineering, and if successful they will be continued and extended in subsequent years.

LETTERS UPON PRACTICAL SUBJECTS.

FOUNDRY MICROMETER FOR TEST BARS.

Editor MACHINERY:

A good deal is said and written at the present time about improved methods and tools in the machine shop—expensive and accurate gages are made and exhaustive tests are taken that the "brains" of the department may have the most complete data to work with, while in the foundry, where the raw material assumes a tangible form, little or no attention is given to the many details which would produce a greater uniformity of results. Not long ago in conversation with the foreman of a large foundry, this point was brought up and it seemed to the writer as if he (the foreman), expressed the sentiment pretty aptly when he said: "After all the available money had been spent for improvements in the machine shop, they would expect the foundry to rejoice that their equipment was so good and needs nothing new, and with the old equipment that had not even been honored by repairs for ages, help pay a dividend."



Foundry Micrometer for Test Bars.

Although, to the average foundry foreman, a micrometer is as much out of place in a foundry as gunpowder, it, nevertheless, has a use there; the foundryman's "hair" has the same limit of elasticity as the blacksmith's, and as experience teaches, can be stretched at will from 0.01 to 0.25 inch with impunity. But many a foundry foreman would appreciate any device that would tell him accurately and quickly the exact amount of shrinkage in a standard ½x½x12-inch test bar cast between chills, that would help to locate serious troubles with the work, and that would in any case furnish a set of data that would give an exact record of shrinkage from day to day, and in different periods of the heat.

The little device shown in the sketch was designed to accomplish this desired result, and as it is clearly illustrated, needs little description. The micrometer screw can be bought from hardware dealers, and the design can be changed to suit the individual taste of the designer. The bar rests on two parallel supports and at the rear of the bar two pins are inserted to keep the specimen parallel. As the bar is cast between chills, the faces presented to the anvil and measuring spindle are fairly smooth and would not produce any excessive wear. While a regular 12-inch micrometer could be used, or a caliper square, the gage as illustrated is designed primarily for the foundry and has the convenience of being, with the supports and device for holding the specimen, self-contained. Its cost is slight and its usefulness will appeal to the practical foundry foreman. V. A. H.

"THE MAN WHO IS THE WHOLE THING."

Editor MACHINERY:

C. M. C. hit the nail on the head in his letter in the October number about the man who is the "whole thing." In the same slang I would like to know, "What are you going to do about it?" A great many men who are in authority are like the section boss, who always got to the car house at 7 o'clock. His regular greeting was, "Put on the cahrr. Good mornin', byes." One morning the men put on the car before the boss arrived. When he did come he swelled up with wrath and indignation. "Who towld yez to put on that cahrr. Take it right off. I'll show yez who's boss!" When they had the car back in the house, he said: "Put on the cahrr. Good mornin', byes."

The proprietor hires a man for foreman, but imagines people will think he is not much unless he shows that he is the "whole thing" himself. What is the foreman to do about it? Perhaps he is getting along in years or is so situated that he cannot very well leave town to hunt for another job. The foreman puts a man on a job; after a while he knows the job ought to be done and goes to see about it, but finds the job hardly started and the man nowhere to be seen. He asks a workman near by where John is. "Oh, the Old Man took him out a good while ago." Now tell me, what is the foreman to do? Perhaps he has promised that job by a certain hour and the time is nearly up. If he complains to the Old Man he will probably get "set down on" good and hard. The Old Man will show him who is boss. I see this almost every day of my life. When the Old Man is not there, the men play horse with the foreman and the Old Man complains that he cannot get a foreman who has any control over his men. Certainly not, though he pays well for it, too. When the Old Man goes out of town he leaves his dudish son in charge, and it is the son's ambition to make people think the business would be paralyzed were it not for him. He goes out in the shop and gives orders to the men, entirely ignoring the foreman. It makes the foreman feel like thirty cents. If some of the readers of MACHINERY can tell me what to do about it, they will greatly oblige a FOREMAN.

MILLING FLOOR GRINDER BASES.

Editor MACHINERY:

Fig. 1 shows the base of a floor grinder strapped on the table of a No. 3 Cincinnati milling machine ready for milling off the caps and the rest shelves. The bases of these grinders (manufactured by a prominent eastern firm) were formerly planed in gangs of eight, each planer head taking a row of four. By this method the time required for planing to fit the caps and also planirg the rest shelves was nearly two-and-a-half hours for each base, while they are now milled in less than one-and-a-quarter hour. Taking into consideration the difference in hour rates of a planer hand and a milling machine boy, the change of method caused a reduction of about seventy per cent in the cost of this operation. Although the casting weighs upward of four hundred pounds, its construction is such that it needs no balancing when strapped to the milling table.

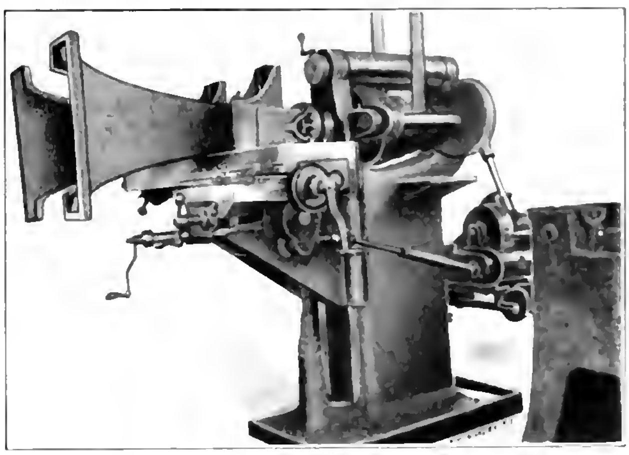


Fig. 1. Floor Grinder Base strapped on Milling Machine

Fig. 2 shows a cross section through the milled part, and Fig. 3 gives an idea of the construction of the cutters. The larger cutter, used for various sizes of bases, is screwed onto the milling machine spindle, while the smaller one, which is slipped off and a new one put on when needed to fit the different requirements, is keyed to an arbor fitting the spindle taper. The cutters are made with cast-iron bodies and inserted teeth of high-speed steel, which, to allow for wear, are driven into slots, tapering at the bottom, as in Fig. 3. This allows the teeth to be driven forward and re-ground to correct dimensions both on face and outside diameter. The

cutters are run at a surface speed of 60 feet per minute, taking a cut ⅛ inch deep with a table travel of one inch per minute. Though this is rather slow for cast-iron milling, the

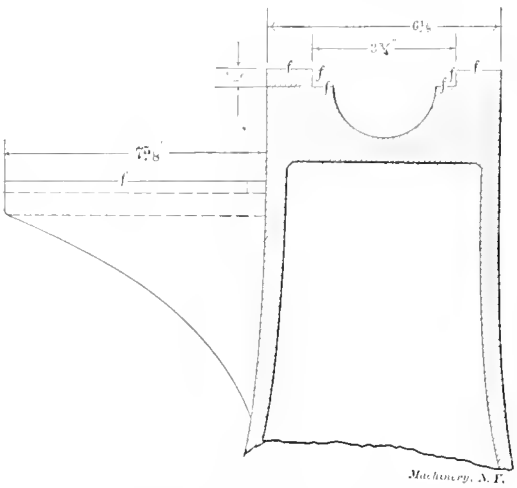


Fig. 2. Cross Section through Milled part of Floor Grinder Base.

cutters stand up so much better that the loss in speed is easily made to pay. J. C. SPENCE.

Worcester, Mass.

ON THE STRENGTH OF TIMBERS.

Editor MACHINERY:

The following discrepancy in relation to the strength of timbers has been called to the attention of the writer by an actual case of construction, and he would like an expression of opinion from some one competent to decide.

It is claimed that Kidwell's tables on the strength of timbers are the only tables known up to date which take into account the shear on the neutral axis of the beam; the author gives this shear as the limiting value for the supporting power of a beam for all spans up to twenty times the depth of the beam. He gives the safe value for shear parallel to the fiber for long-leaf yellow pine as 150 pounds per square inch, which is based upon a factor of safety of 4, the safe unit tension or compression resulting from flexure being given as 1,200 pounds per square inch, which is based upon a factor of 6.

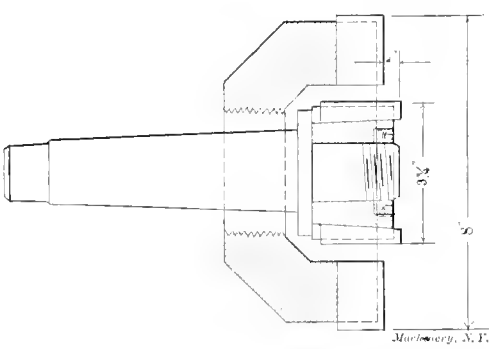


Fig. 3. Construction of Cutter for Milling Grinder Bases.

For 1,500 pounds per square inch working stress, he gives the supporting power of long-leaf yellow pine timbers, based upon shear at the neutral axis, about as follows:

Depth of Beam.	Spans up to	Total Safe Load per inch of Width.
6 inches	10 feet	600 pounds
8 inches	13 feet	800 pounds
10 inches	16 feet	1,000 pounds
12 inches	20 feet	1,200 pounds

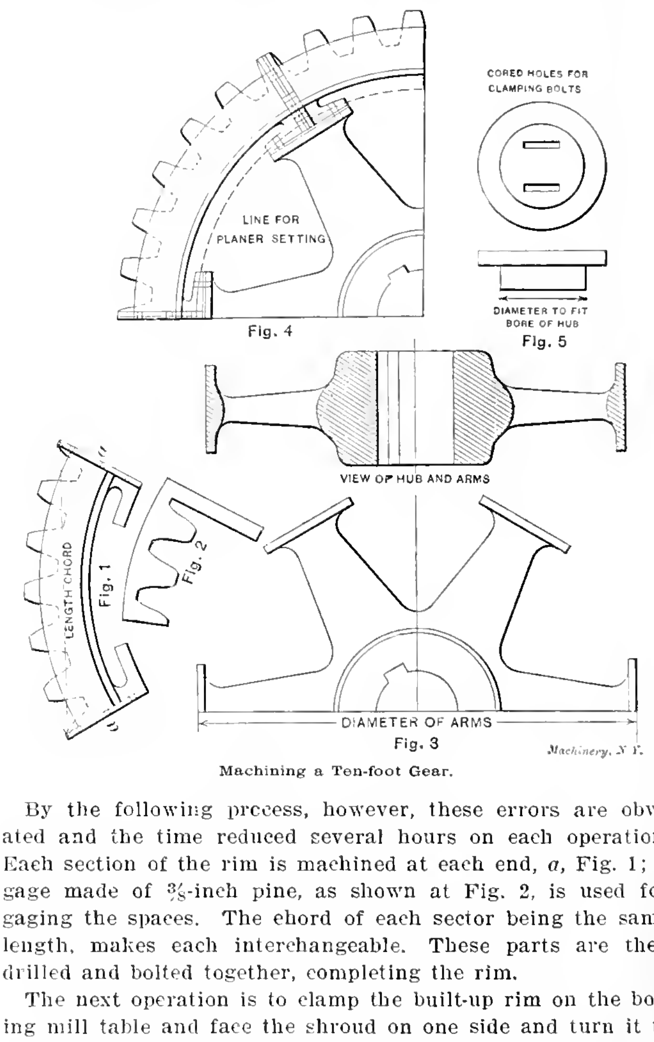
Now from another authority—Applied Mechanics, by Gaetano Lanza, 7th edition, pages 319 to 321—the vertical shear on a rectangular beam = 2-3 bds, where b = breadth and d = depth of beam, and s = intensity of shear on the neutral axis. If we take $s = 150$ pounds per square inch for long-leaf yellow pine, as stated by Kidwell; then, vertical shear $= 2/3\ bd150 = 100bd$; letting $b = 1$ inch, vertical shear $= 100\ d$; or for a timber 12 inches deep, the safe vertical shear would equal $100 \times 12 = 1{,}200$ pounds per inch of width; or if the load be a uniformly distributed or concentrated load in the center, in either of which cases the vertical shear is one-half the total load on the beam, the supporting power of the beam would be $2 \times 1{,}200 = 2{,}400$ pounds per inch of width instead of 1,200 pounds, as given in Kidwell's tables. In other words, a timber that I would figure to be a 6×12 inch should, by Kidwell's tables, be 12×12 inches.

Philadelphia, Pa. JOHN S. MYERS.

MACHINING A TEN-FOOT GEAR.

Editor MACHINERY:

In pursuing the following method of machining built-up gear wheels the idea was to overcome the liability to error, which invariably resulted when the parts were machined by the old method employed in this shop, and which caused no end of worry and delay when assembling the wheel. The specifications require that all parts be interchangeable, which is rarely the case by the old method, and the gain of time is of considerable moment. It is customary in machining built-up wheels of this type to first machine each segment of the rim at the ends a, Fig. 1, then bolt two segments together and plane the pad for spoke; these segments are then taken apart and the next segment bolted to one so as to plane the other end, etc. This method requires the time of bolting each segment and taking down after planing, and so on throughout the wheel; when assembling began some parts would be found wanting and others too long.



Machining a Ten-foot Gear.

By the following process, however, these errors are obviated and the time reduced several hours on each operation. Each section of the rim is machined at each end, a, Fig. 1; a gage made of ⅜-inch pine, as shown at Fig. 2, is used for gaging the spaces. The chord of each sector being the same length, makes each interchangeable. These parts are then drilled and bolted together, completing the rim.

The next operation is to clamp the built-up rim on the boring mill table and face the shroud on one side and turn it to the pitch diameter; at the same setting the flat surfaces for the arm pads are bored back far enough to serve as a guide line and of a diameter to correspond with the diameter of the arms, Fig. 3. A line is scribed, as shown in Fig. 4, which is marked with a prick punch at each intersecting line where two sectors join. This line is for the convenience of the planer hand in bolting rim on the planer; hence its diameter is optional. A long, 5-foot angle-plate was clamped to the planer platen, and the rim bolted to the angle plate, with the faced side, having the prick punches, facing the housings. A surface gage measuring from top of rail to two prick punches diagonally opposite served to set in position for machining the five bored pads at one setting. By moving rail and setting

heads over the proper angles four pads were machined with down feed and the other with horizontal feed.

If all the arms are planed the same length from center of hub, which is readily done with the fixture shown in Fig. 5, no difficulty should be encountered in making the rim fit nicely over the ends of the arms. An allowance of 0.010 inch was found to make a nice fit. GEO. L. RENNEISEN.

Louisville, Ky.

MAKING T-SLOT CUTTERS.

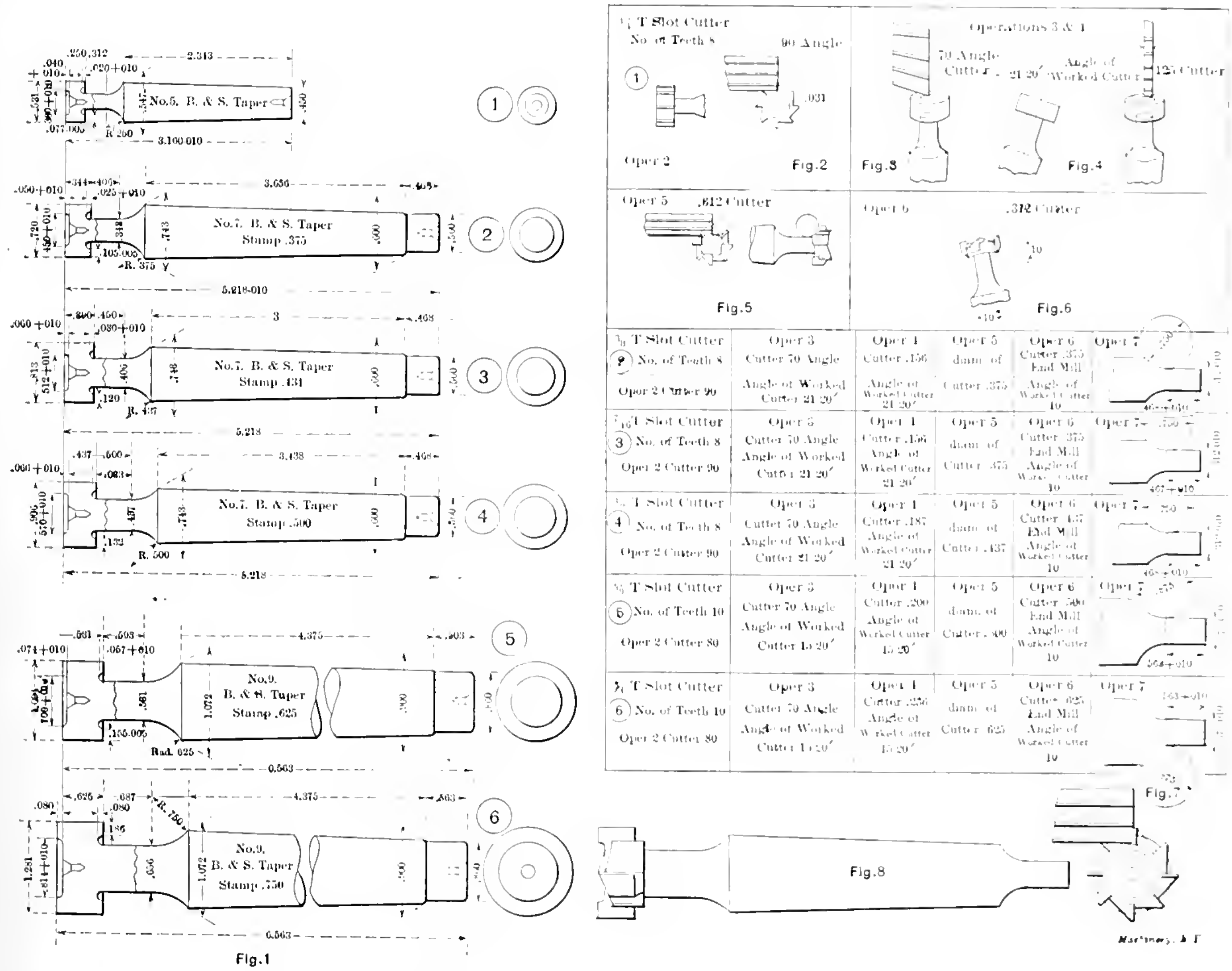
Editor MACHINERY:

This type of cutter has gradually and successfully outclassed the old-style method of the planing T-slots in milling machine tables and other classes of machinery where T-slots are regularly used. It has not only outclassed the planer and shaper in the time required, but in the quality of the work done. With this in view, the writer has drawn out a series of operations and tools to assist those who may have this sort of tool to make. As will be seen from the drawings, the cutter is made completely by machining ready for the hardener. Where many are to be made it insures uniformity of each cutter throughout. In the first operation is shown the turning part or the lathe work necessary. In all cases where grinding has to be done add 0.010 inch; to the cutter part add 0.020, which is sufficient for that purpose. In the following operations we will take a ¼-inch cutter as an example:

The first operation, of course, is the turning. The second operation, shown in Fig. 2, is milling the teeth on the outside; an end mill of about ⅝-inch or ¾-inch is recommended. The number of teeth given is 8; angle of cutter required, in this case, 90 degrees. The third operation, as shown in Fig. 3, is milling the teeth on the face. In this operation the worked cutter, which is the cutter being made, should be placed at an angle of 21 deg. 20 min. from the vertical line, this angle being suitable also for the fourth operation. In the third operation, the working cutter required is an angle cutter of 70 degrees; while the worked cutter is in this position we commence the fourth operation, which is gashing every other tooth. It is an essential feature that clearance for chips should be considered in these cutters; the cutter required in this operation is an ordinary ⅛-inch slotting cutter. In operation No. 5 a similar gashing of the teeth takes place, but on the back instead of the front. The worked cutter is held in a horizontal position, and the working cutter is a 5-16-inch end mill. Operation No. 6 is the backing off of the teeth at the back. The same working cutter can be used as in operation No. 5, the worked cutter being held in a vertical position at an angle of 10 degrees.

In the ¼-inch cutter no tongue is necessary, or is made. As will be seen in the tables below the illustrated operations, all above this size are made with a tongue on the end of the shank; therefore operation No. 7 gives the end mill required and sizes of the tongue. At the bottom of the series of operations is shown a complete cutter, Fig. 8. J. LORD.

Birmingham, England.



Operations and Tools for Making T-Slot Cutters.

IMPROVISED VERTICAL MILLING MACHINE.

Editor MACHINERY:

For finishing plane surfaces, such as caps and bosses, especially in cast iron, the face mill used in the milling machine is by far the best tool, as it gives an accurate surface, smooth finish, and is two or even three times faster than other methods. The most convenient means of holding such pieces on the plain miller, in the vise or by bolts and straps, does not, however, give one much chance to use a face mill, and the spiral cutter, being more convenient as regards holding the work, is used in preference, but it is not as rapid as the face mill and perhaps is not as good as the planer or shaper. The

face mill, used in the vertical miller, is the ideal cutter, as it is rapid and accurate, and the pieces can be held conveniently while the cutting is in plain view.

Almost the same results can be obtained by placing an ordinary milling machine under a large upright drill; the driving pulley of the drill should be directly under the countershaft, and the drill should be swung at an angle, using a quarter-turn belt, or less, so that the drill spindle will be over the milling machine table. Belt the milling machine up in the usual way. Do not locate the drill spindle directly over the center of the table, and then two pieces can be worked on at once, if wished, by using a cutter on the milling arbor and a face mill held in the drill spindle. A special collet must be made for the drill spindle so it will use standard cutters, or an arbor with screw end provided to take standard face mills. In use the drill spindle is run down to the stop by the handwheel, and all backlash should be adjusted down to the finest point; fine adjustments vertically are obtained by the miller. This arrangement does not handicap the milling machine for the ordinary range of work, while the vertical face mill feature will more than pay for the trouble of moving and setting up the machine. CHARLES E. BURNS.

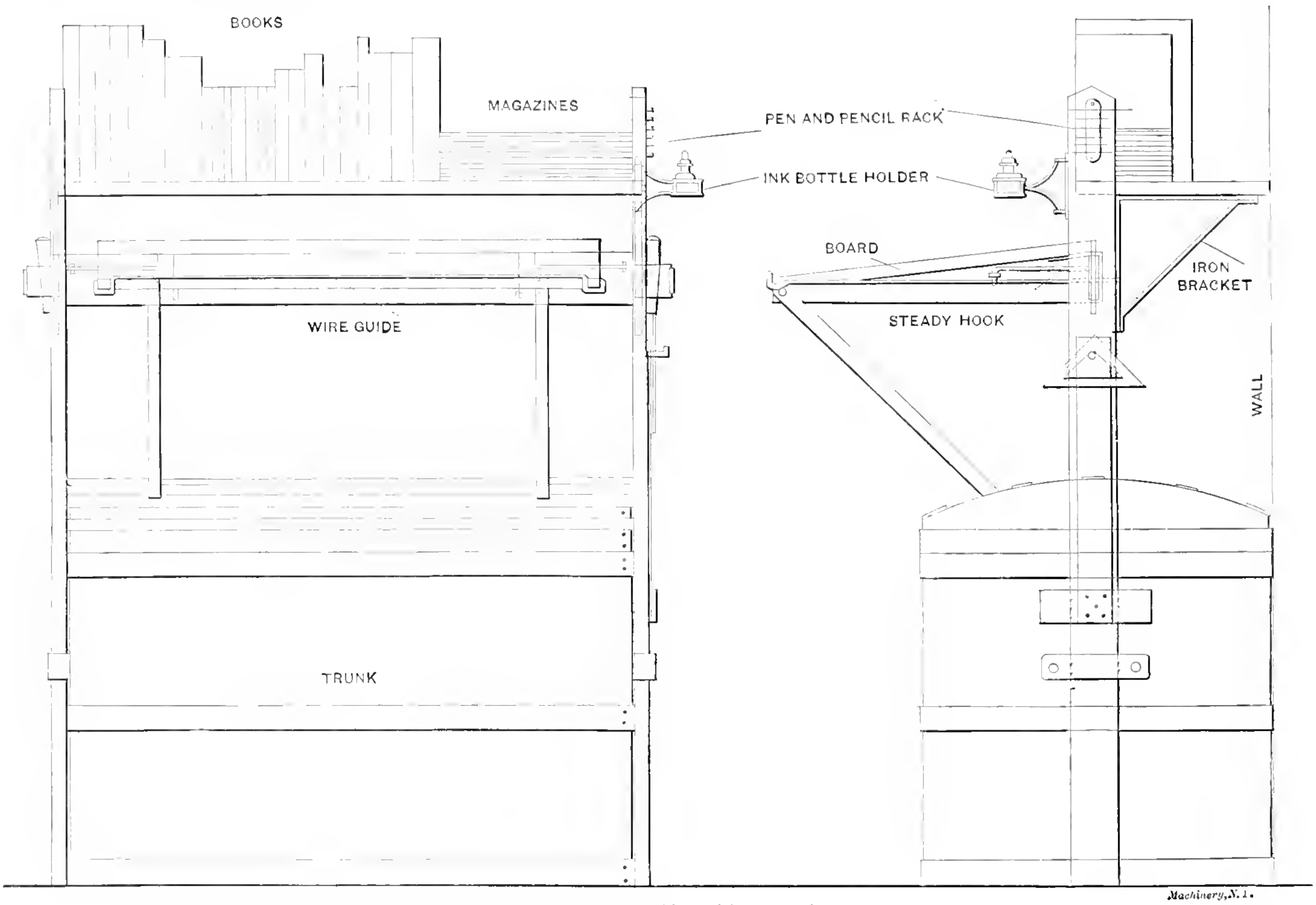
Boston Mass.

DRAWING TABLE AND BOOKSTAND FOR TRAVELING MECHANICS.

Editor MACHINERY:

The cut shows a portable drawing table and bookstand, designed and made by myself. As I have found it very useful and handy, no doubt many another traveling mechanic may find it of use to him. It includes two uprights of such a width that they will fit tightly into the handles of the trunk in connection with which it is used. The height may be determined by the user according as to whether he may wish to stand or sit while at work. Between these uprights is a cross or tie-rail about one inch thick with a long tenon on each end, fitting into mortises in the uprights and held by wooden wedge keys. Secured to the back edge of the drawing board is a sheet metal strap, bent downward to hook over the tie-rail. The bracket arms supporting the board are held sideways by hooks screwed to the cross-rail and fitting into eyes screwed into the wood brackets. At the front end, as shown, are steadyrests which, resting on the trunk, help also to steady it the other way. I also threaded a wire at each end and put it through holes in the cross-rail, with a thumb-nut and washer on each side to hold the board sideways and prevent it from moving on the cross-rail. The peculiar shape in which the wire was bent can be seen in the cuts; it can be bent up a little higher in front to keep articles from sliding off the board if desired. At the back of the uprights iron brackets are screwed on, which support the shelf for books and magazines. The shelf can be extended and other shelves can be put on if desired. I made a swinging ink bottle holder of metal, and also attached to the uprights a pen and pencil holder, and a hook on which may be hung T-squares, triangles, etc. The whole is easily and cheaply made, and easily and quickly taken apart, folded for moving, and put together again. While it may not look so, it is quite firm and steady.

J. H. A.



Portable Drawing Table and Bookstand.

SHOULD MACHINES BE BOLTED DOWN?

Editor MACHINERY:

Should machines be bolted down? This question is or should be often in the minds of engineers connected with machine tools. The only thing to be said in favor of the practice is that the floor or bed prepared for the machine takes part of the stresses and absorbs some of the vibration. The advantage in having a machine loose is that if the floor subsides or becomes much out of truth—and some floors are prone to this objectionable habit—it does not tend to strain the frame so much out of truth. Also the machine can be more easily removed. There are, of course, some few machines which, from the nature of their work, must be bolted down, either on account of excessive vibration, or because the character of the operation calls for a design which is "top heavy." The majority of machine tools engaged on ordinary work, however, could, and I think should, be designed with sufficient strength and rigidity to absorb all working stresses and vibrations without being bolted down. This applies especially to motor-driven tools, which from the ease of setting up driving connections should be more portable than belt-driven ones. A matter not irrelevant to this

subject is the position of the motor. One often sees it on or near the top of the machine, where, though appearances may be enhanced, it is not conducive to extra steadiness. It is better in most cases to extend the base and put the motor on it, though when in that position it need not look as much like an afterthought as it generally does. If the motor is not included in the framing, the vibrations are not so liable to be transmitted to the machine. As an instance of a fairly heavy tool which has been run permanently without being bolted down, I may mention a vertical miller weighing between 6 and 7 tons. This was leveled up with wooden wedges which extended all around the base, the wedges afterward being sawn even with the edge of the machine. We also run planers unbolted, sizes up to 3 x 3 feet being leveled up with wedges and larger sizes put on concrete. We have experienced no trouble with them up to the present; they do not move with the shock of the table reversal as perhaps would be expected, running as some of them do at 24 feet per minute cutting and 72 feet per minute return.

I should like to know if any of your readers have had trouble in setting up machines on wooden briquette floors, as I once had a fairly rough experience with one, the foundation being too loose. The tops of the briquettes were in anything but one plane, and unfortunately they sank unevenly even after we made them smooth on top.

McAnic.

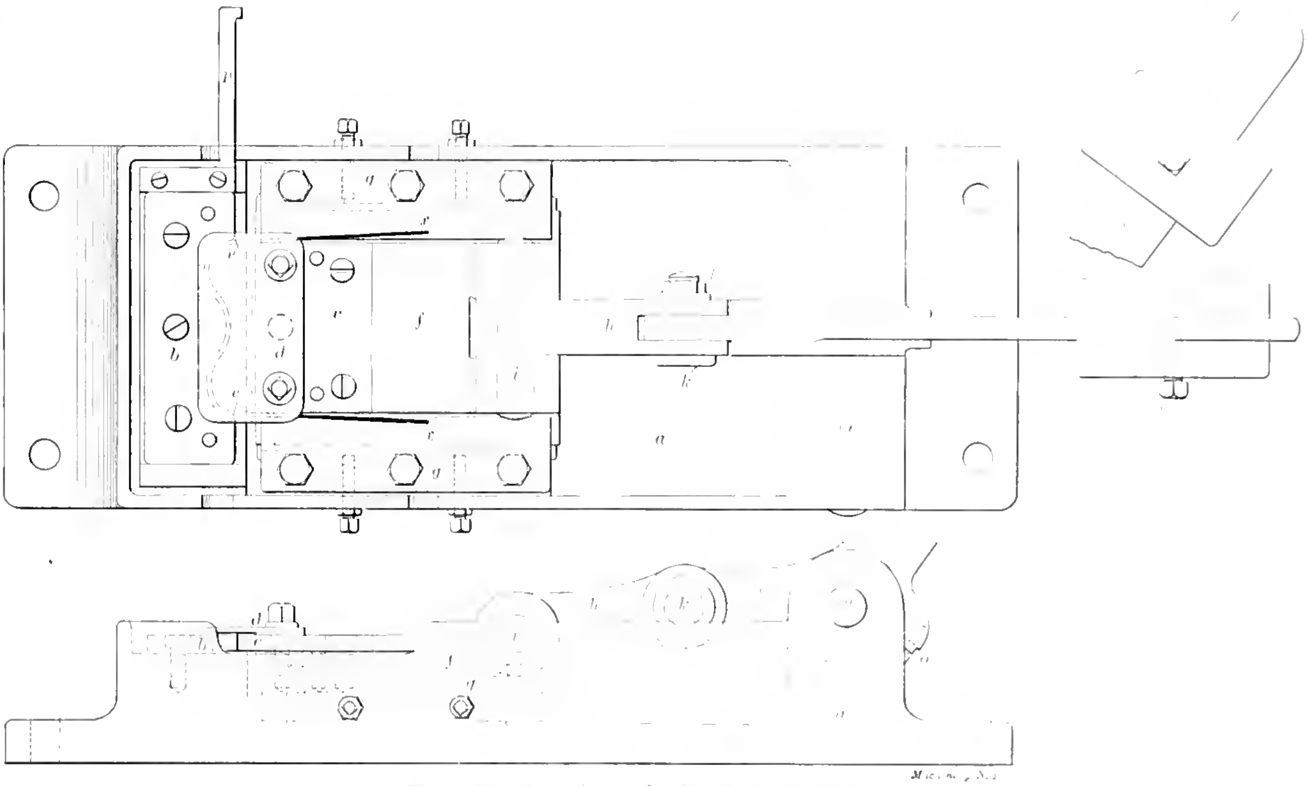


Fig. 1. First Operation for Bending Spring Steel Shape

SET OF BENDING FIXTURES FOR TWO OPERATIONS.

Editor Machinery:

The bending fixtures shown herewith were designed for bending 7-16-inch by 3-32-inch spring steel to the shape shown at black line, *x*, Fig. 2, in two operations, with only one heating for each operation. The first operation is performed in the fixture shown in Fig. 1, the spring steel piece, *x*, being bent into the form indicated by the black and dotted line. It will be noticed that it is a hard, stiff bend, and one that requires powerful leverage to enable it to be done by hand. The bending must be uniform and exactly interchangeable to gage fit. The fixture was designed so as to accommodate different shapes in bending by exchanging the formers.

The frame, *a*, is of gray cast iron, made with a hole in each corner for belting solidly to the bench, with the handle at the right by the side of the operator. The frame is made with thin walls at the sides so as to form a pocket or reservoir for lard oil which is used on the formers when bending; with a brush in his left hand the operator brushes some oil across the face of the outside jaw before each bending operation. The steel must be heated very low, just hot enough so that the red can be discerned. The formers, *b* and *c*, are made of tool steel and are held in position with three screws and two dowel pins. The inside corners of *b* at *e e* are rounded so as not to cut the metal when it is forced into the former. Before making the formers it is necessary to ascertain the correct shape as they must be such as to form the desired shape for the finished piece after it has been hardened. The shape can be calculated very closely by men accustomed to the work, or it can be found by trial, by using a few pairs of samples bent to the approximate shape, and trying one of each pair until one is found right after being hardened. The former is then shaped to the mate. The plate, *d*, held to the top of *c* by two screws, is for keeping the ends of the piece in alignment during the bending operation; at the same time it prevents the oil from flashing upward and burning the operator. The T-slide, *f*, carrying former, *c*, is made of cast iron and is finished all over. It is held down by two steel plates, *g*, which in turn are clamped with three screws on each side. Two steel gibs are provided on each side with gib screws and lock nuts to keep the slide in a central position, and to compensate for wear. At the rear end of the T-slide is a toggle joint consisting of the links *h* and *j*, and the bearing pins *i*, *k* and *m*. The pin, *i*, is made of tool steel and is a driving fit in the slide, *f*, and a turning fit in *h*. The screw *k* is drawn up solid to a shoulder with the nut *l*, and is a turning fit in *h* and . The handle, *j*, swings on the pivot pin, *m*, which is made a driving fit in *j* and a turning fit in the frame casing. On the extreme end of the handle, *j*, is fastened a cast-iron weight or block, so as to be adjustable by loosening the screw, *n*. The block on the handle weighs 50 pounds, and this weight together with the toggle-joint action makes the machine very easy to operate, although a heavy pressure is required for the bending. To prevent drawing the metal too much, screw stops *o* are provided which limit the movement of the handle in the forming operation. These screws are made of tool steel and are spring-tempered. Stops are also provided for limiting the withdrawal movement of the formers as indicated in the cut. The stop *p* is clamped to the fixture with two screws, and is used to locate the metal accurately before bending so that each leg of *x* will be of the same length. The walls of the casing are cut away only sufficiently to allow the ends to pass over freely. The operator picks up the metal from the fire by tongs held in the left hand, and places it against the stop *p* and the face of the former. With the right hand he moves the handle *j* and the first movement of *d* locates the metal in

a horizontal plane, since there is only just enough room for it to pass over freely. The bending is done rapidly.

The second operation required for bending the ends around is performed in the fixture shown in Fig. 2. This fixture includes the frame casting *a* which has a hole in each corner for bolting it securely to a bench, with the clamping handle *d* on the opposite side from the operator. With a turn of this handle he clamps the piece *x* between *e* and *b*, and then with the right and left hands on the sliding handles *l l*, a simultaneous inward movement bends the legs of *x* around to the shape shown. In the center of the casing is the former *b* fastened securely by four screws and four pins. This former requires the same attention in design as the ones described in connection with Fig. 1; it is made in the same manner after having ascertained the right shape, of tool steel, tempered to a straw color. The tool steel sliding block *e* is fitted in a groove planed in the casing, and is provided with a suitable cap for holding it in position. It is tapped out in the center to fit the screw of the handle *d*. On its face it fits *b*, and both conform to the shape produced in the first bending operation. On each side of the casting *a* are planed two 45-degree dovetailed grooves which are provided with gibs and screws for adjustment. In these grooves slide the blocks *h*, carrying the roller holders *i*. These roller holders are free to swivel on the screws and each carries two small rollers, one of which rolls on the inside of the cam *c*, and the other bears against the piece *x* being bent. A flat spring on one side holds the roller holder continuously against the cam *c*. The rollers and holder are casehardened, made of machinery steel, as also is the cam *c*. The handles *l* are mounted on the sliding blocks *h* so as to move longitudinally, the holes for the screws being elongated for this purpose. C. O. P.

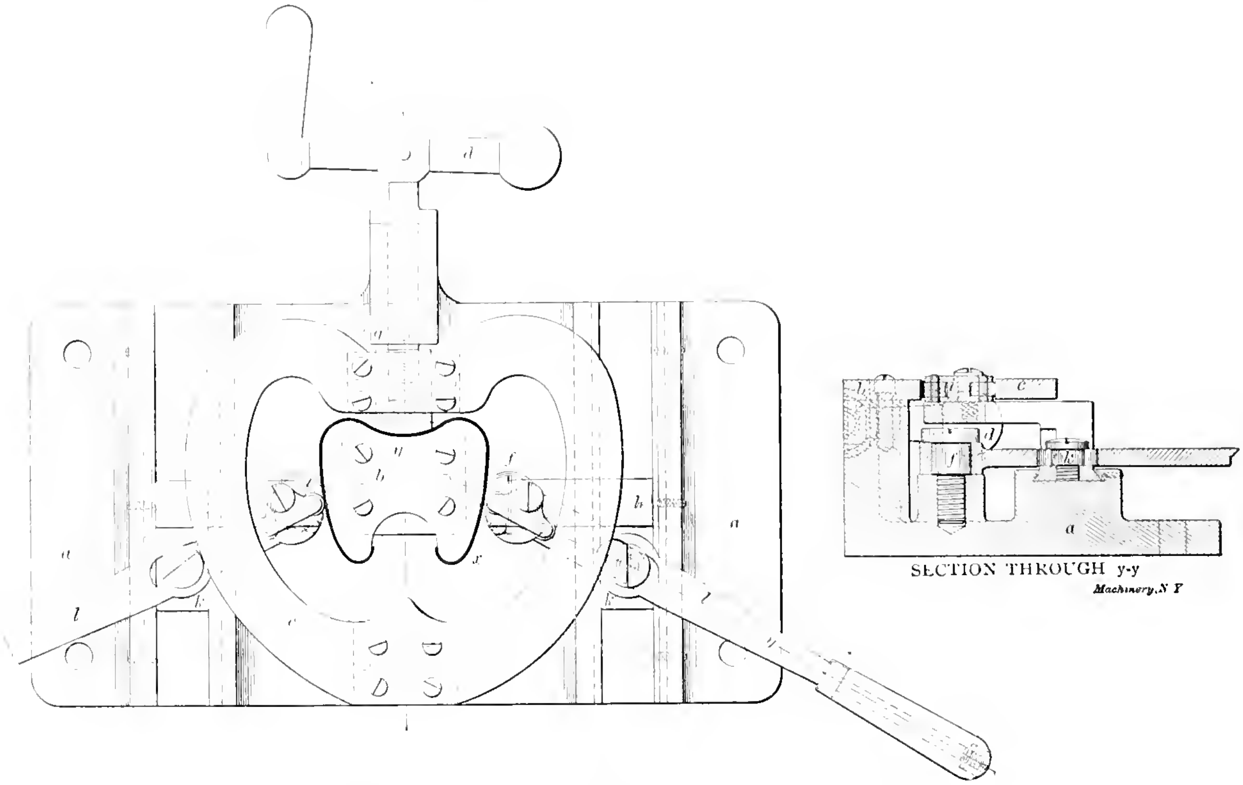


Fig 2. Operation for Completing the Bending of Spring Steel Shape.

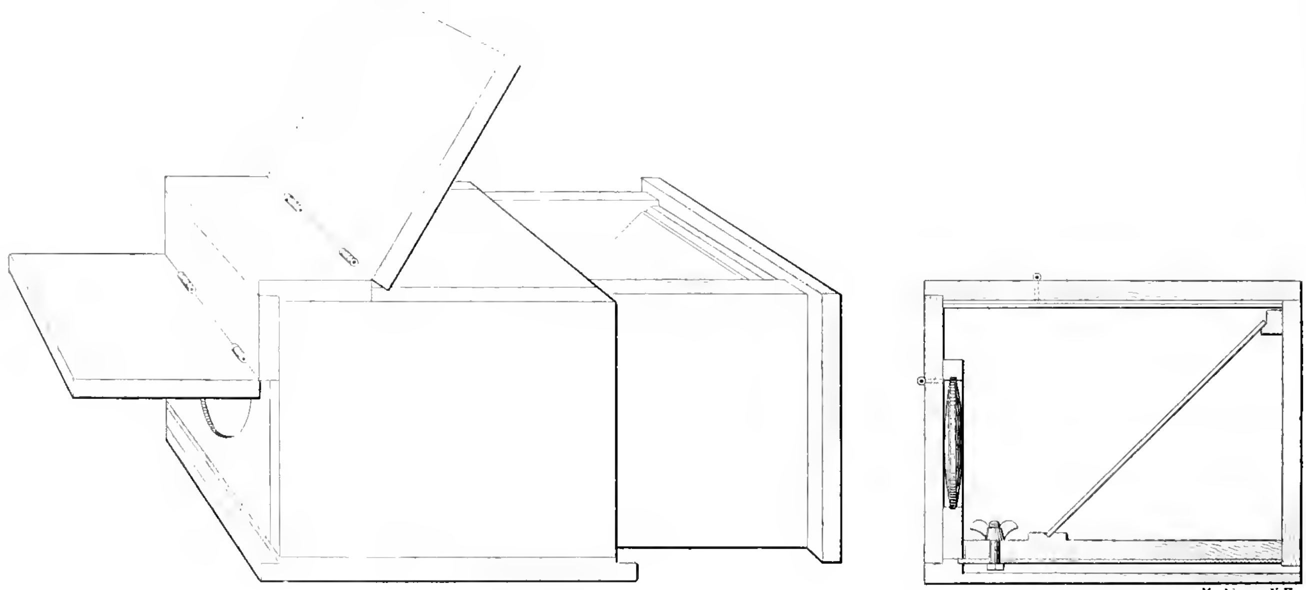


Fig. 1. Fig. 2.

Perspective View and Longitudinal Section of a Sketching Camera.

A SKETCHING CAMERA.

Editor MACHINERY:

To make free-hand sketches of machinery, or other similar objects, that are clear, well-proportioned and accurate in detail, is an accomplishment that requires an amount of skill, experience and artistic ability not commonly possessed; yet, such sketches are frequently of great importance, for reference and in designing additions and changes to existing structures. Recourse is often had to photography, but a photograph is not always readily obtainable; the light may not be right, and even

if a successful exposure is obtained, the developing of the plates, printing, toning and drying of negatives and other detail work take time, are somewhat expensive, and may not result satisfactorily; then, too, the surface of a print is not a good ground on which to put dimensions, etc., and such marks cannot possibly be made at the time of making the exposure. Draftsmen and others who may desire to make such views, with speed and accuracy, do not need to be told of the difficulties encountered, and some may be pleased to find a practical aid in an old, yet interesting, device, here shown, which is really a modified camera, known as a "camera obscura," sketching camera or mirrorgraph.

The whole apparatus is so simple that any one handy with tools can readily construct it; the first expense is the total expense, there being none consequent upon its use. A perspective view of the camera, with the slide partially withdrawn, and a longitudinal section, showing the interior arrangement, are given in Figs. 1 and 2 (previous page). A box, or frame, of thin wood, rectangular in shape, and of any convenient size, as say 10 inches long, by 8 wide and 7 inches high, is the foundation; it has a solid bottom, two plain sides, cover and front end, portions of each of which are free to swing on the hinges; the back end is entirely open; near the top, and along both inside edges are narrow strips for supporting the glass sketching surface; at the front, inside the hinged cover, is a frame to hold the lens. The slide has a base plate running the entire length inside the box; two triangular sides, and an upright back, which forms a part of the box when closed; from side to side, at the top and bottom, are cleats to support the mirror and in front of the bottom cleat, in the center of the base, are a bolt and thumb-nut for securing the slide to the base board, the latter being grooved, or T-slotted, for the head of the bolt to travel in.

All the interior parts should be finished in a dull—not glossy—black, so that the light rays may not be reflected. The cleats, on the slide, support a plain mirror, set at an angle of about 45 degrees; the exact angle can best be determined by experiment, as it depends somewhat on the length of the box and focus of the lens. A plain box, without the drawer feature, the mirror being stationary, can be used with fairly good results, but the arrangement shown allows a better focus to be obtained, or rather, the apparatus can be better adjusted as to distance from the object it is focused on. Directly above the mirror, and level with the top surface of the sides of the box, is placed a pane of ground glass; this can be covered, when not in use, by the hinged top as indicated; the latter, when raised, forms a shade on the drawing surface from rays of direct light.

The outside of the case may be finished as nicely as is desired, provided with trimmings, carrying straps, etc., to suit one's taste; it may be arranged to mount on a tripod, but the essential feature required is firmness—absolute—as, if it moves in the least, while making the sketch, the drawing is likely to be spoiled. The lens preferably used is a double-convex, of rather long focus, wide angle, and of comparatively large diameter, so as to admit a relatively large volume of light rays into the camera; an old reading, or magnifying glass answers the purpose completely.

When the camera is properly focused and secured, it will be found that an image of the object appears clearly on the ground glass, in all its natural colors, and will show through a sheet of tracing paper, placed on the glass, sufficiently well to admit of penciling it in. A perspective picture is easily obtained of the whole, or as much as may be desired, of the object, in far less time than by ordinary methods; any desired dimensions, or notes, can be added to the drawing at the time of making it and a very complete and satisfactory sketch results.

WARREN E. WILLIS.

Philadelphia, Pa.

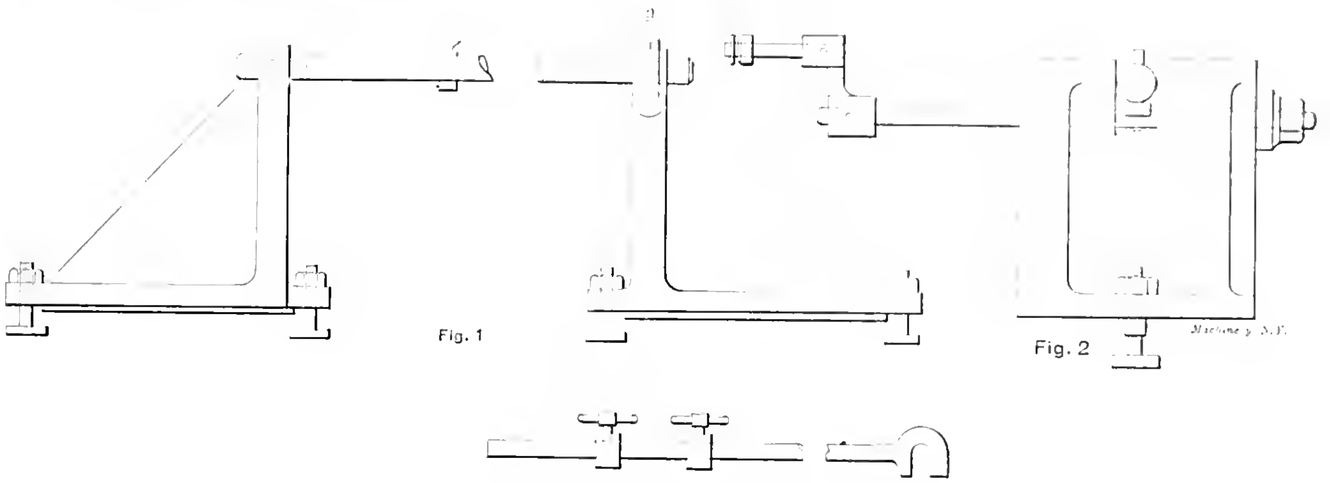


Fig. 1

Fig. 2

Fig. 3

Construction of a Keyseating Attachment for Planers

KEYSEATING PLANER ATTACHMENT.

Editor MACHINERY:

The accompanying sketches illustrate a keyseating attachment, for planers, consisting of two very heavy angle pieces with heavy braces cast on the back, several bars, of sizes to suit holes of different diameters, and a faceplate or chuck which is fitted to the vertical slide in the place of the tool clapper. The bar, Fig. 1, is slightly flattened at one end, and a hole is drilled to receive a pin, which goes through the top of the angle piece, and hinges the bar to it. Near the center of this bar a slot is cut to receive the cutter, which is held in

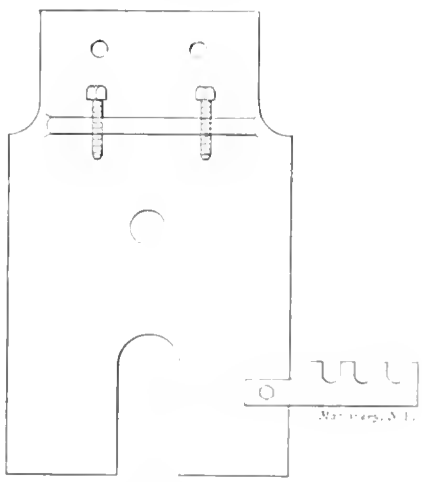


Fig. 4

Faceplate of Planer Attachment

place by a taper key. The other end of the bar rests on a cam in the front angle piece, which is illustrated in Fig. 2. The rod, Fig. 3, fits on the crankpin and slides through one of the notches in the piece, which is bolted to the side of the faceplate. The set-collars can be adjusted so that when the planer is running, the crank will be moved enough at the end of each cutting stroke to move the cam from under the end of the bar, allowing it to drop sufficiently for the cutter to clear on the return stroke, at the end of which the other set-collar strikes and moves the cam under the bar again, ready for the next cut. The faceplate, Fig. 4, as stated above, takes the

place of the tool clapper, and the work is bolted to it, being fed to the tool by the regular vertical feed. There is a rib, or projection, near the top of this faceplate into which two or more setscrews are tapped to keep the work from slipping. Holes must be drilled or slots cored in the faceplate for bolting down the work.

It will at once be apparent to the practical mind that the range of work done by this attachment is limited, as to the diameter of pulleys, etc., but for keyseating flanges, or compression couplings, or slotting the ends of connecting rods, it will be found very powerful and rapid. C. P. L.

ACCURATE JIG MAKING.

Editor MACHINERY:

It was not my intention to ask for any more space in your columns on the subject of accurate jig making, but one sentence in the letter of Jig Maker, in the January issue, to the effect that the argument be carried to the end for the benefit of the younger readers, leads me to ask for your indulgence once more.

Jig Maker has come as an unexpected witness to the correctness of the method I have described, and I ask no better testimony than his, in corroboration of the position I have taken. He says he has knowledge of a factory in which the jigs used must deliver the finished product correct, to within 0.0001 inch. Now if this is so, and I believe it to be true, then it disposes once and for all of the claim that the drill is unreliable, for when work can be drilled to within 0.0001 inch, no greater accuracy can be desired. If drills can be used in that particular factory with such exact results, it follows that they can be used in other shops with the same results. Now when I make a jig upon the drill-press plan, I simply use a jig to make a jig, which I will prove by taking the reader through the process once more.

I will, however, first state that the first four chances of error that Mr. Shailor found and that Jig Maker seems to think are valid, would never be allowed to exist by any toolmaker competent to make an accurate jig. In other words, if he cannot eliminate these alleged chances of error, he could not make an accurate jig any way, no matter what method be used. The fifth chance for error (the possibility that the table of the drill press may be out of square with the spindle), may or may not exist. If it does, it, too, must as surely be removed for making the jig, as it just as surely had to be removed before the jigs, that Jig Maker has told us about, could deliver their work accurate to within 0.0001 inch. It is my opinion that the drill press that delivered such accurate work was very carefully examined to see that its table stood square with its spindle or spindles, and if it did not, it was made to do so before the work was proceeded with.

With these points disposed of I am up to the point of making my jig, that is to say, I have a drill press, holding a drill in its chuck, which fits the hole in a bushing, held by a bracket fastened to the frame of the drill press, and below is a table that stands square with the spindle of the drill. With this assurance, the next move is to prepare the table to receive the work. This is done by fastening two parallel strips to the table, by means of clamps, at any given distance desired from the bushing. The way to do this was described in the October, 1902, MACHINERY. One of the parallel clamps is fastened at right angles to the other.

Now, Jig Maker, I will take your jig that delivers us work correct to within 0.0001 inch, and using it upon another drill press that has been examined and corrected, will produce a piece of work from it, and at the same time duplicate it upon my drill-press plan. We will say that it has three holes in it, and they are spaced 1 inch apart from center to center. Now, I drill one hole in the work in your jig, and then I drill a hole in my jig plate, which I have previously placed as follows: The plate is laid upon the table, and the edge nearest to me is brought to rest against two round pieces of steel of equal diameter, say 1/4 inch, and these in turn rest against the parallel strip, which of course must have a straight edge. The left-hand end of the plate is next brought to rest against a similar round piece of steel, and I am ready to drill. So far we stand upon equal ground with a hole drilled in the work in your jig and a hole drilled in the plate in my jig.

The second hole in the work in your jig is drilled by moving the jig along 1 inch, when it is ready for the drill; or, if a multiple spindle drill is used, simply bring the spindle down, or the table up, according to the type of machine. My second hole is obtained in this manner: The plate is moved along the table, and in place of the 1/4-inch diameter steel piece that rested against the parallel on the left of the table, I use a steel gage that is 1 1/4 inches long, which is brought to rest against the parallel, and against which the plate is brought to bear. Now, if we have calipered the two pieces correctly, then the position of the plate has changed just 1 inch, and when the hole is drilled it will be just 1 inch from the other, measuring from center to center.

But, you say, that my drill is going to run out, and consequently the work will not be true; yours did not, it did its work true to 0.0001 inch, and I cannot understand why you think my drill is any more unreliable than yours. You also say that my gages may not be correct, that I may have given more or less pressure to one than to the other, yet you further state that you set the buttons on your plate, when making the jig, so accurately that the work from the jig is correct to within 0.0001 inch. If you can do this, others should be able to do as much, and it is no more difficult to caliper a short gage correctly than it is to set a button from two different edges of a plate.

To find the position of the third hole in my jig plate, I substitute for the 1 1/4-inch gage a gage that is 2 1/4 inches long, and proceed as before. When this hole is drilled it, too, will be just 1 inch from the second hole, and 2 inches from the first hole, for I have your word for it that work from jigs can be correct to within 0.0001 inch. Now, when I drill these holes I use a drill smaller than the hole is to be when it is ready for the bushing, and I do not drill it through the plate as I do not want to throw a burr up on the bottom of the plate. Just as other work from jigs is afterward operated upon, so will I operate upon my jig plate, and, if the work from your jig may be counterbored, reamed, tapped, recessed, etc., and still maintain its accuracy, so may my jig plate be further operated upon and keep its accuracy.

Mr. Jig Maker, when you have drilled a piece of work in a jig correct to within 0.0001 inch, and it is necessary in order to finish the piece to ream out one hole and counterbore another hole, do you bore the hole out before reaming, and do you find it necessary to chuck the piece to counterbore the other hole, to the end that the piece will interchange with some other piece of work that is also correct to within 0.0001 inch? I think not, and, if it is not necessary for you to do so, then why is it necessary for me?

The example of small jig making that Jig Maker has given is evidently an error. I think it should read .03 of an inch for the diameter of the gear instead of .3 of an inch. If so, it is indeed a very small piece of work; but, from the whole tenor of Jig Maker's letter, I am led to believe that he thinks that small work only requires great exactness, and very close measurements.

He asks your readers to seriously consider the drill-press plan of making the jig for this piece of work. I ask your readers to seriously consider the plan of making such a hole on an angle-plate of a milling machine; first setting the button correctly, next finding its position on the milling machine, then boring the hole out true, and next reaming it out. Just consider the difficulty of feeding the heavy table, table housing, and saddle against a boring tool that must enter a hole, perhaps less than 1-16 inch diameter, and that, too with the work in such a position that it cannot be seen by the operator. To my way of thinking it would seem a good deal like driving a very small tack with a 24-pound sledge hammer. If I had such a piece of work to do I would use the faceplate of a watch toolmaker's lathe, arranged in the manner I mentioned in the October, 1902, MACHINERY. It differs only from the drill-press plan in that it has no bushing to support the opening drill, and thus requires the hole to be bored out before it can be made to run true. All the center distances are obtained by gages as in the drill-press plan.

Jig Maker seems to think I was trying to work a "flim flam" when I stated the conditions under which a drill should be used to obtain a true hole. They were, first, that the drill should be started true. Surely Jig Maker should not expect a drill to run true that is started out of truth, and that drills used with bushings to start them do run true we have his word for. Second, that it will continue true if it is not crowded in the work. Jig Maker says this crowding occurs, but that it does is no excuse or reason for it. It is a fact that more hard work is put upon drills than any other tool used by machinists simply because, I suppose, they will stand it without breaking; if a boring tool was crowded in anything like the manner that drills are, it would be impossible to bore a hole true. Third, that the density of the metal be not changed by blowholes. Jig Maker says that blowholes are encountered, and the drill will thus change its path. It is my belief that when the jig was made that has been given us as an example by Jig Maker, it had no blowholes in it, or if it did, they were plugged up, or the casting, if a casting was used, was thrown away, which is exactly what should be done in any other similar case. Jig Maker says that in addition to the ten chances of error that Mr. Shailor found, he can name ten more, and, consequently, there is but one chance in twenty of my jig being correct. This, of course, applies to each hole, and if there are ten holes in the jig, then there is but one chance in two hundred of its being correct when finished. If this is true of the work from my jig, or rather the the system (which is, as I have stated before, but a jig), then it is also true of any other work that is made in a jig, and from these premises there can be no such thing as interchangeable work having holes, unless they are made with a corrected screw on a milling machine, or by the button method of locating the position of the work. We know, however, that work is made in jigs that is interchangeable with other work, and that, too, when it is done upon the despised drill press, and often in the hands of boys and girls, or other people of little mechanical knowledge, whereas, with my jig system the work is done by men who are supposed to be mechanics and to know when conditions are right or wrong.

Brooklyn, N. Y. J. R. GORDON.

BALL BEARINGS.

W. O. Renkin

Editor MACHINERY:

In the October issue of MACHINERY I notice a question, No. 11, referring to the carrying capacity of ball and roller bearings. I have had some experience with ball bearings, and as my results differ somewhat from those given in your answer, they may be of interest to your readers. Where the races are made as in Fig. 1, I find the following rule satisfactory for hardened steel balls of 1 inch or less in diameter:

Safe load in pounds = $(\text{diameter} \times 10)^2 \times 31$.

Example: For a ⅝-inch ball the safe load will equal $(⅝ \times 10)^2 \times 31 = 39.0625 \times 31 = 1{,}210$ pounds. For a ¼, ½, ¾, and 1-inch ball, we find the safe loads to be:

¼-inch ball = 2.5 × 2.5 × 31 = 193¾ pounds.
½-inch ball = 5 × 5 × 31 = 775 pounds.
¾-inch ball = 7.5 × 7.5 × 31 = 1,743¾ pounds.
1-inch ball = 10 × 10 × 31 = 3,100 pounds.

This is considerably lower than if one-tenth of the breaking load is taken as the safe load, as given in your answer, the results there being as follows:

¼-inch ball = 6,000 × .10 = 600 pounds.
½-inch ball = 30,000 × .10 = 3,000 pounds.
¾-inch ball = 54,000 × .10 = 5,400 pounds.
1-inch ball = 77,000 × .10 = 7,700 pounds.

For balls greater than 1 inch in diameter, I find the safe load by using the formula $(\text{diameter} \times 10)^2 \times 26.5$, though this is only for 1⅛, 1¼, 1½, and 1¾-inch balls, as I have had no experience with larger sizes. I find that in calculating it is advisable to add from 25 to 35 per cent to the total load on

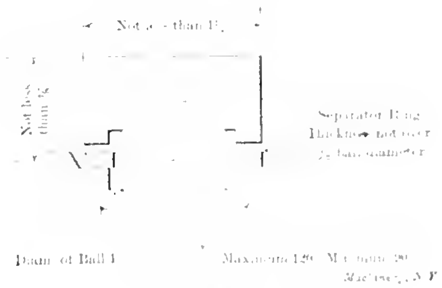


Fig. 1. Shape of Ball Races

bearings, so as to reduce the wear and tear on both balls and races, which are always expensive. Moreover, in the case of step bearings or plates for vertical shafts, I generally use three less than the number of balls in the bearing for my calculation, for example:

For a step-bearing with twenty ¾-inch balls in one or more rows, take the total number of balls, say two rows of 20 each, equals $40 - 3 = 37$; then, $37 \times (\text{diameter} \times 10)^2 \times 31 =$ 64,518.75 pounds = total safe load. Where a ball bearing is to be used as an axle or horizontal-shaft bearing, I take the total number of balls × 6-19; thus, taking an axle bearing of three rows of ½-inch balls, with 12 balls in each row, we have: $(3 \times 12) \times 6\text{-}19 = 11\ 7\text{-}19$. Combining the whole number next lowest, in this case 11, with our formula, we have $11 \times (0.5 \times 10)^2 \times 31 = 8{,}525$ pounds as the safe load for this bearing.

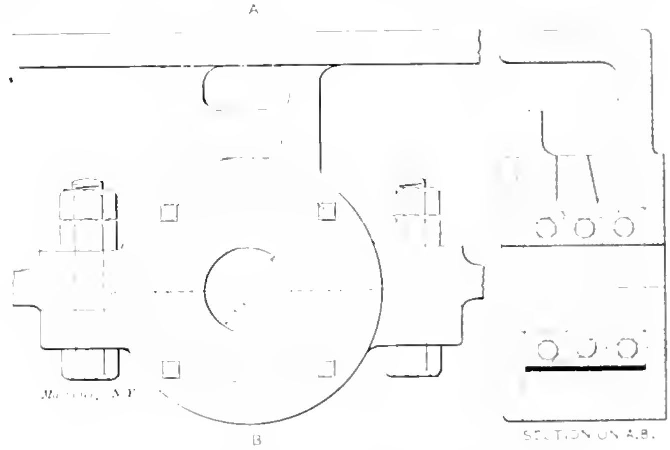


Fig. 2. Heavy Ball Bearing for Plate Glass Casting Table

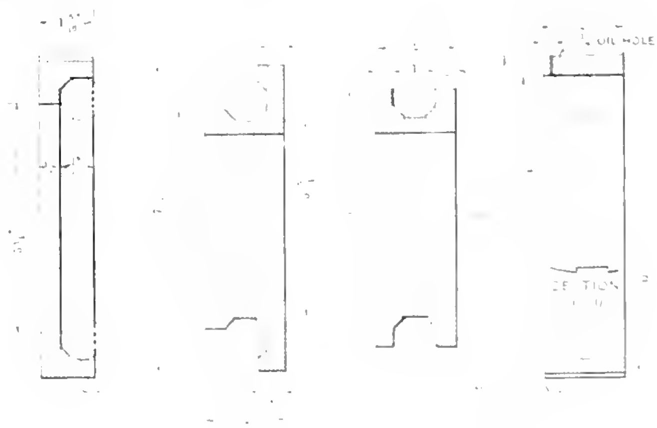


Fig. 3. Details of the Bearing Rings

Figs. 2 and 3 show a heavy bearing we had built for a transfer table where we wanted a bearing that could be readily taken apart and examined, and one that would cause no wear either in the axle or in the bearing frame. The table is used in casting plate glass and is very heavy, being 18 feet 6 inches long and 11 feet 1 inches wide. The outer rings of the bear-

WILLIAM O. RENKIN, born at Allegheny, Pa., 1875, is now engineer in charge of the drawing office of the St. Louis Plate Glass Co. He took a special course in the Renkin Shops at Allegheny after completing a six years apprenticeship. Mr. Renkin has been employed by the Union Foundry Mach. Co., the H. C. Frick Coke Co., the Pittsburg Plate Glass Co., the Kittanning Plate Glass Co., and the Converse Transformer Co. He has had charge of selling and designing tooth gears, testing and building coal mining machinery and works, and designing and building a plate glass making plant; also large machines for high voltage power transmission.

ing are keyed to the bearing frame and the inner ones to the axle, and both being a slipping fit, when the table expands the bearings can slip out on the axle without disturbing the gage of the wheels. W. O. RENKIN.

Valley Park, Mo.

CUTTING MULTIPLE THREADS WITH A CHASER

Editor MACHINERY:

In regard to the article written by Mr. R. B. Casey, of Schenectady, N.Y., in the December, 1904, number, I cannot see how he could have cut a triple thread 3½ turns to the inch with a 10-thread chaser, and he did not say how the lathe was geared. If I had been doing it, I would have used a 10½-thread chaser and would have geared the lathe to cut 3½ threads per inch. A short time ago I had a similar job; it was a double 3½ thread which was to be cut so as to mesh with a 7-pitch single thread, the double thread, of course, running two to one. I geared the lathe to cut 3½ threads per inch, and used a 7-pitch chaser. A Reed lathe was used with a 6-pitch leadscrew, and the coarsest pitch thread on the index plate was 4 turns to the inch. The compound gears were 2 and 1, so I geared the lathe to cut 7 turns per inch, and reversed the compound gears, thus making it cut 3½ turns to the inch. Perhaps you or some of your readers can explain to me so I can understand how Mr. Casey did it.

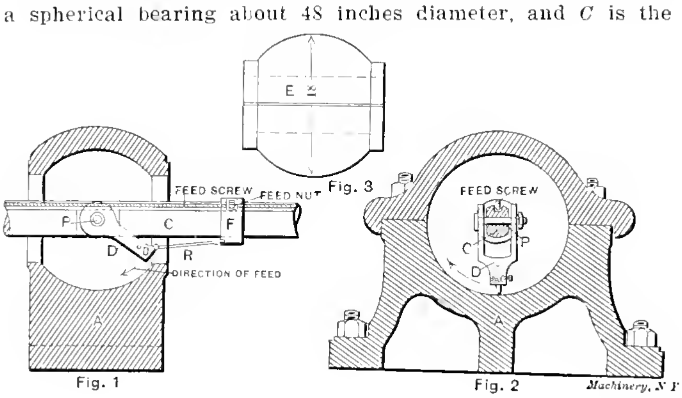
Providence, R. I. T. E. REMINGTON.

[A typographical error in Mr. Casey's letter made it read 3½ threads per inch, whereas it should have read 3 1-3, or 3-10 lead. This is obvious in the two following lines.—EDITOR.]

RADIAL ATTACHMENT FOR BORING BAR.

Editor MACHINERY:

The following method is, I think, as simple a one as could be devised for turning out spherical bearings in pedestals; it was used in building the engines for the Brooklyn Rapid Transit Co. In the accompanying cut *A* is the pedestal with a spherical bearing about 48 inches diameter, and *C* is the



Radial Attachment for Boring Bar.

boring bar, flattened a little on each side so that the atttachment, *D*, would have some side bearing when fitted on. Pin *P* was put through for the bar to swing on, as shown in Fig. 2. Two lugs were cast on the outer end of the arm *D*, from which connection was made to the collar *F*, Fig. 1, by rod *R*, and the whole device was driven by bar *C*, the collar being carried along by the feed screw. As the bar turns the movement of the feed screw causes the arm *D* and the cutting tool to traverse the arc of a circle; hence the combination of the two motions—feed and boring—bores the shape of a ball.

The bushing *E*, Fig. 3, was bored to size for the shaft, and then turned in the lathe. The toolpost was bolted to a swinging table, which was fastened to the bed of the lathe and pulled round by a spring belt attached to the carriage and driven by a feed screw. This was a simple and cheap arrangement, and by its use we made a very good job of both the bearings and bushings. D. LINDSAY.

Plainfield, N. J.

REGARDING ACCURACY OF JIGS.

Editor MACHINERY:

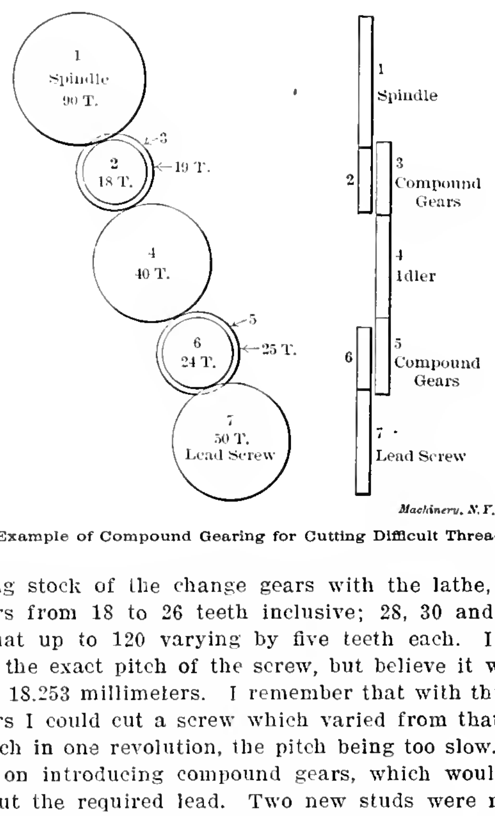
I wish to say a few words in regard to the controversy between Messrs. Shailor, Gordon and "Jig-Maker." No doubt each of these gentlemen considers his method of making jigs the correct one, and so it is on the class of work on which it may be used. It is a well-known fact, however, that undue accuracy and finish are very expensive and are to be avoided whenever possible, but in some manufacturing plants the greater degree of accuracy attained in the construction of the tools the easier it is to properly assemble the product. During my own experience I can say that I have made some very accurate tools, and then again I have made some that I would be ashamed to show to toolmakers like Messrs. Shailor and "Jig-Maker." But they have all accomplished their object, and that seems to me to be the prime consideration. If the young toolmaker will remember that the purpose of his daily toil is to enable his employer to earn profits he can readily judge for himself the amount of accuracy and finish required on a certain tool. I believe in the highest possible standard of accuracy consistent with an adequate return on the money invested, for it is in this way only that the toolmakers and other employes can hope for the material advancement which must come to them when the factory is managed on a paying basis. H. J. BACHMANN.

New York.

CUTTING ENGLISH-SYSTEM THREADS ON A METRIC LATHE.

Editor MACHINERY:

I frequently had some very difficult screw-cutting work while working some years ago in a machine shop in Paris, France. Our worst troubles arose from having to cut English-system pitch screws on a metric lathe having a leadscrew of 10 millimeters lead. On one occasion two days were spent by the foreman and one of the oldest lathe hands in trying to find change of gears to cut a certain pitch, calculation having been given up. But the job, a brass nut 5 inches long with triple thread to fit a screw, was pressing and something had to be done. I was finally called upon to solve the problem.



Example of Compound Gearing for Cutting Difficult Thread.

Taking stock of the change gears with the lathe, I found all gears from 18 to 26 teeth inclusive; 28, 30 and 35, and from that up to 120 varying by five teeth each. I am not sure of the exact pitch of the screw, but believe it was 23-32 inch, or 18.253 millimeters. I remember that with three regular gears I could cut a screw which varied from that desired 0.010 inch in one revolution, the pitch being too slow. I then figured on introducing compound gears, which would enable us to cut the required lead. Two new studs were made for compounding and on one 18- and 19-tooth gears were placed, and on the other 24- and 25-tooth gears. The 18-tooth gear was meshed with the lathe spindle gear, and the 19-tooth gear with an idler which drove the 25- and 24-tooth gears on the second stud. The latter gear meshed with the change gear on the leadscrew. I have found this arrangement very useful for cutting any odd pitch screw, that is inserting compound gears to suit the case. EUGENE WOPALETZKY.

Trenton, N. J.

SHOP RECEIPTS AND FORMULAS.

Practical Tried Receipts—those known to be Good—are Solicited.

CEMENT FOR SLICKING LEATHER FILLET ON BRASS PATTERNS.

Melt together 8 parts pure beeswax and 2 parts rosin; cut into strips when cold and apply with a slicking tool of the proper radius. A piece of wire set into a steel ball, and heated over a Bunsen burner is the best for this purpose. The pattern should be slightly warmed to enable the cement to flow between the leather and brass. When cold any superfluous cement may be removed with a piece of waste soaked in spirits of turpentine. H. J. BACHMANN.

New York.

TO MOTTLE CASEHARDENED PIECES.

A simple and effective way to get a mottled effect in casehardening with cyanide of potassium is as follows: Set an open pail or jar under a running hydrant, get the pieces good and hot (bright red) in a ladle of molten cyanide, then take out singly with tweezers and simply throw them into the water. The air bubbles rising through the water give the desired mottled effect. A still better process, if an air blast is at hand, is to connect a rubber hose in some manner to the bottom of the pail, so that a stream of air enters the water. This plan serves well where no special appliance is available for this class of work. HARRY ASH.

Chicago, Ill.

TO COAT ZINC SHEET BLACK FOR TEMPLET WORK.

In answer to question No. 16 in the December issue of MACHINERY for a receipt for coating zinc or tin sheets black for templet work, I send the following, taken from Brown & Sharpe's book on gearing, page 85:

"Dissolve 1 ounce of sulphate of copper (blue vitriol) in about 4 ounces of water, and add about one-half teaspoonful of nitric acid. Apply a thin coating with a piece of waste."

Chattanooga, Tenn. ALEX. C. LABAR.

FILLER FOR DEFECTIVE CASTINGS.

I herewith give you a formula for filling defects and blow holes in castings. I have been using this receipt for years and it is the result of many experiments: 1½ parts litharge, 2½ parts dextrine; 4 parts iron borings or turnings carefully sifted. Mix the parts well, add water until the mass is of about the consistency of mortar. With a putty knife or other instrument fill the defective parts and press into every crevice. Let it "set" for 48 hours, when it can be chipped, planed, bored, or turned like the casting itself. Color with lampblack to suit shade of casting.

To facilitate the measuring of parts, use a box of three divisions, made to the following dimensions: The division for borings should be 4 inches long, 2 inches wide, 1 inch deep; for dextrine, 4 inches long, 1¼ wide, 1 inch deep; for litharge 4 inches long, ¾ inch wide, 1 inch deep.

York, Pa. W. W. BIRNSTOCK.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

The following questions are referred to the readers:

27. C. K. Will you kindly inform me of any prescription for thinning lard oil after it has gotten thick from use.

28. W. C. W. How are the wire handles made that are used on stove doors, pokers, lid-lifters, etc? They are wound of spring wire, small at each end and large in the center to fit the band.

29. H. T. M. Does the "angle of pressure" of spur gears cut with the Brown & Sharpe cutters alter when the number of teeth falls below 30?

A. The angle of pressure should remain constant in all involute tooth systems, and with the Brown & Sharpe system it is 75½ degrees throughout the range from a 12-tooth pinion to a rack. In an interchangeable system like this where high and low-numbered gears are likely to work together it is necessary to round off the points of the teeth, to avoid interference, which also applies to the rack tooth, but the rounding off does not change the angle of pressure. With worm gears, however, it is desirable to retain a straight-sided tooth in the worm, but below 30 teeth a straight-sided tooth causes undercutting of the wormwheel. To avoid this, the angle of the worm thread is sometimes changed. The rule given in "Formulas in Gearing" is:

$$\cos\gamma = \sqrt{1 - \frac{2}{N}}$$

2γ = angle of worm thread,

N = number of teeth in wormwheel.

Using this formula, the included angle of worm thread for a 17-tooth wormwheel, for example, is found to be 40 degrees, nearly. Some manufacturers believe that this angle should have been adopted for the involute tooth system instead of the one now generally used.

30. H. P. R. Having been laid up a few days with a sore eye, caused by a particle of emery wheel grit, I wish to ask: 1. What is the best way to avoid the sparks from an emery wheel when tool grinding? 2. What strength of cocaine should be used to render the eye insensitive when removing grit imbedded therein? 3. What is a simple remedy for inflammation.

A.—When an emery wheel sparks and throws grit badly it is evidence that it is not adapted to the work, or is in need of truing up with the dresser. When a wheel is in good condition the greater part of the debris will be thrown directly down from the work, and little will fly from the wheel above the tool. When using an emery wheel the operator should always stand, if possible, to one side of the plane of rotation. In this position he will avoid flying particles and the more serious danger of flying fragments in case the wheel bursts. 2. Druggists recommend a cocaine solution of from one to two per cent strength for eye work, but it should be employed very cautiously, and we should, in general, advise against its use by the inexperienced. 3. Salt water applied with an eye glass or cup during the day, and soaked in absorbent cotton and bound over the eye at night, is perhaps the simplest and best remedy for inflammation, caused by foreign substances; it has the merit of being harmless in any case, which cannot be said of some eye lotions.

31. P. J. M. A regular lathe leadscrew is 3⅜ inches diameter over the top of the thread and 2 7-16 inches diameter at the root, and the lead is 1 inch; what would be the length of six turns of the thread if they were unwound and straightened?

A. Theoretically, your proposition is impossible since the moment we attempt to straighten a helical coil, it is distorted and loses its identity; in other words helical surfaces cannot be projected on a plane. Practically, however, the metal represented in the top of the thread would be compressed and that at the root, stretched, the relative amount of compression and stretch depending upon the metal and the position of the neutral axis, which latter in turn depends upon the shape of the thread section. For an approximately square or rectangular section this would coincide with the middle axis. Therefore for the sake of simplicity it will be assumed that the length of the thread when unwound would equal the length of the helix located midway between the top and root of the thread. The length of this helix is found as follows: The depth of the thread groove is (3⅜ — 2 7-16) ÷ 2 = 15-32 inch, hence the mean diameter of the thread section is 2 7-16 + 15-32 = 2 29-32 inches, and the mean circumference is 2 29-32 × 3.1416 = 9.13 inches. The circumference and lead of thread elements correspond to the two sides of a right-angled triangle, and the helix corresponds to the hypotenuse. Hence $\sqrt{9.13^2 + 1^2}$ = 9.185 inches, length of one turn, and the length of six turns would be 9.185 × 6 = 55.11 inches.

* * *

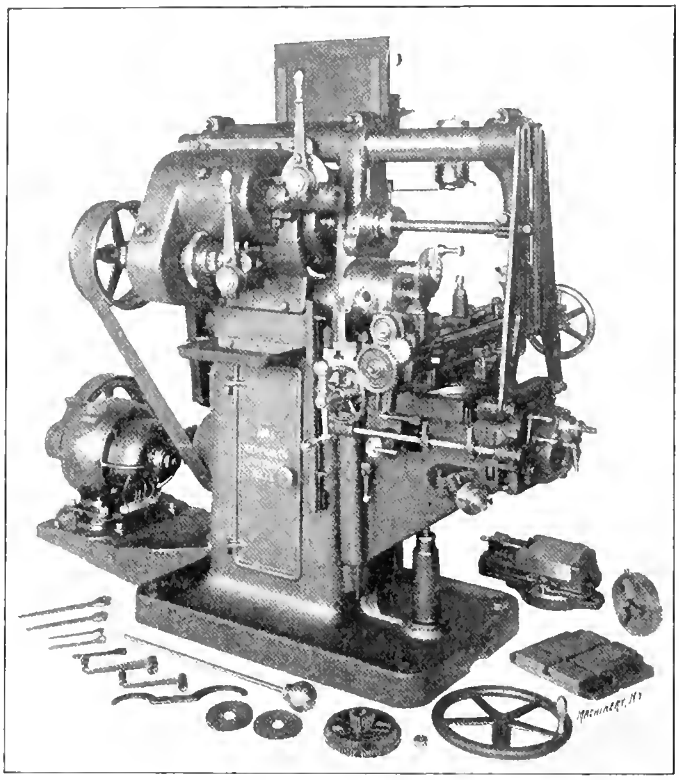
The next convention of the National Machine Tool Builders Association will meet at Washington on Tuesday, April 11, 1905.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

MOTOR-DRIVEN MILLING MACHINE.

The accompanying illustration shows a new universal milling machine, equipped with a motor drive, which the Kempsmith Mfg. Co., Milwaukee, Wis., have designed and are now building. The motor is of the constant speed type, back geared, and is rated at 1½ horse power; it is mounted on a stand bolted to the main casting. The back gear shaft of the motor is connected to the driving shaft of the machine by belt or silent chain as preferred.



Motor-driven Kempsmith Miller.

The variable speed mechanism on the miller provides a range of sixteen changes, obtained through ring frictions. This method is of advantage in that it permits the combination for any desired speed to be thrown in while the machine is running full, without interfering with its operation. The changes are obtained through levers located at the front of the mechanism. A table of speeds placed on the machine gives the different speeds and data for obtaining same.

All feeds to the table are positive and automatic. The feed gear box is recessed into the column, thus being rigidly supported without any overhanging part. It is driven by sprocket chain direct from spindle, the sprocket wheel being keyed to main spindle. Through the levers shown on the gear box, 16 changes of feed are readily available, in geometrical progression. An index plate on the front of the box shows the entire range and the necessary combination to obtain any desired feed. The levers for reversing all feeds, and for automatically tripping all feeds at any time, are centrally located at front of the knee.

The column, base, and bridge for overhanging arm are cast in a single piece. The starting box is mounted above the machine, where it is securely out of the way.

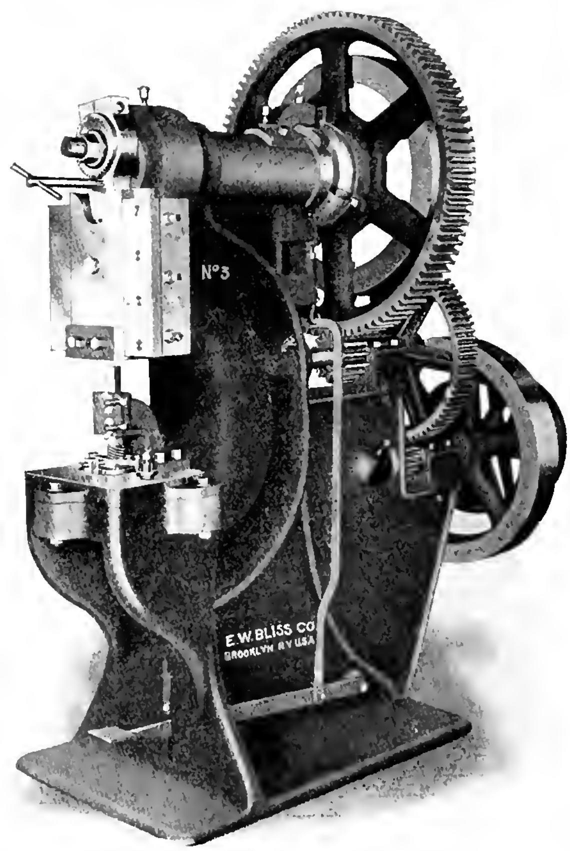
The swiveling table is clamped at any position by an improved bevel clamping ring. The illustration shows the improved construction of side center tailstock which permits the use of large diameter end milling cutters up to within ⅛ inch of the center. This center can be readily elevated for milling tapers. The telescopic elevating screw permits the table to travel to its lowest point without requiring a hole in floor or foundation.

This method of motor drive may be applied to the machine at any time after its completion, as illustrated, or it may be incorporated in the machine while building, in which case the builders are able to render the construction somewhat more compact in appearance.

BLISS BROACHING PRESS.

The E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., have just brought out a machine which, though resembling the regular Styles power punching press of their manufacture, is a modification of this machine, adapting it to a special purpose. The accompanying illustration shows the novel arrangement of gearing, as well as the work for which the press has been designed.

The press was made especially for broaching and has a distance of 12 inches between the bed and the slide, with the stroke and adjustment up. The stroke of the slide is 3 inches. The flywheel weighs 250 pounds. The ratio of gearing is 36½ to 1. A belt rim is bolted to the large gear, so that when the gearing is disconnected the press may be run singly. Disconnecting the gearing is effected by throwing out of mesh the pinion on the intermediate shaft.



Bliss Broaching Press.

The broaching fixture is shown in position in the half tone view. The broach is so made that it will fall right through the press after the broaching operation. Great saving can be effected by the broaching process in finishing castings and the strong, slow motion of the slide in this press gives very smooth results.

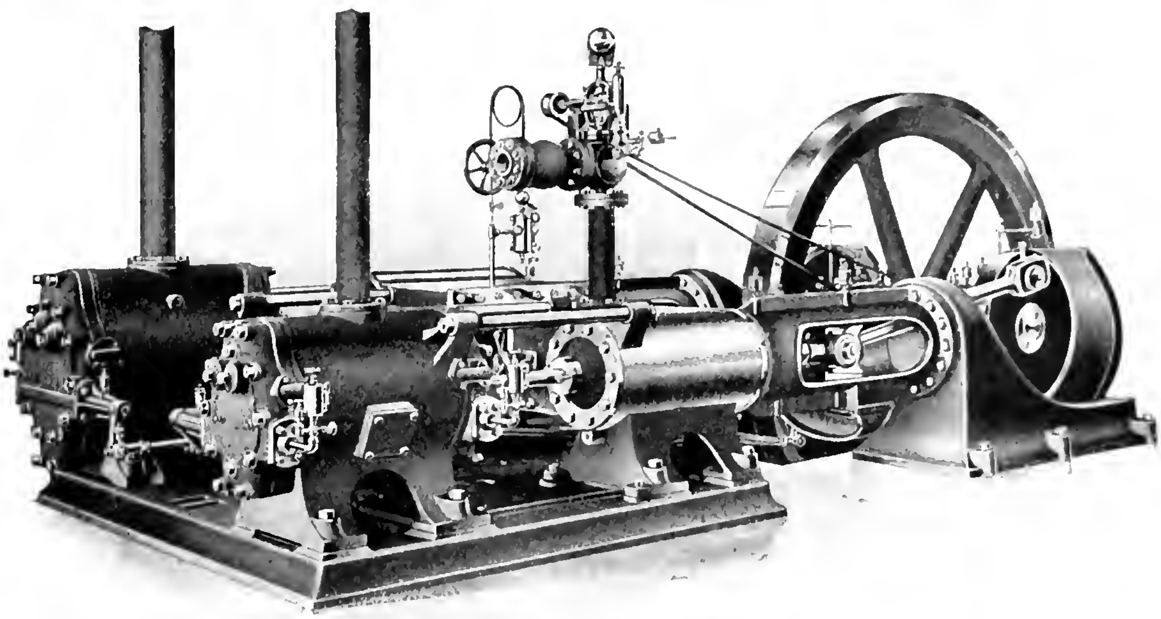
The total weight of the press as shown is 3,800 pounds.

A NEW FRANKLIN AIR COMPRESSOR.

The Chicago Pneumatic Tool Co. have recently built at their Franklin, Pa., plant a number of their latest type of air compressors to be used by the Pennsylvania Railroad in their shops at Altoona. These compressors are furnished with mechanically-operated inlet valves for the air cylinders and Meyer adjustable cut-off valves for the steam cylinders, steam and air cylinders both being compounded. The high and low-pressure steam cylinders are 11 and 20 inches diameter,

respectively, and air cylinders 11 and 18 inches with a stroke of 24 inches. The capacity of each compressor is 700 cubic feet of free air at a speed of 100 revolutions per minute. The steam cylinders are non-condensing, and are designed for a boiler pressure of 100 pounds.

The main steam valves are double-ported, and balanced. The air inlet valves on both air cylinders are of the Corliss type, and are actuated by the steam cut-off eccentrics, so that four eccentrics drive both steam and air valves. The air discharge valves are of the poppet type, and are cup-shaped, pressed out of sheet steel. Valve seats and guides are removable and readily accessible.



New Franklin Air Compressor.

An intercooler is provided between high- and low-pressure air cylinders, which, being self-contained, can be placed whereever it is desired. This intercooler cools the air after compression in the low-pressure cyinder down to the temperature of the atmosphere.

The governor is furnished with a pressure regulator which brings the machine to a stop when the receiver pressure has reached a desired amount, starting it again upon a drop in pressure. The governor is also provided with a safety stop.

Owing to the small bore of cylinders and proportionately long stroke, the percentage of clearance is small. A single sole plate extends under the four cylinders, to which they are doweled, thus aiding in setting up and maintaining alignment.

CINCINNATI BACK-GEARED CRANK SHAPER.

The Cincinnati Shaper Co., Cincinnati, O., have recently redesigned their 16-inch back-geared crank shaper, shown in the accompanying figure. Quite a number of changes have been made in this machine, one of the most notable of which is the increase in the ratio of the gearing, with the back gears in, from 12 to 1 to 24 to 1, making the shaper very powerful. The machine has been strengthened throughout accordingly.

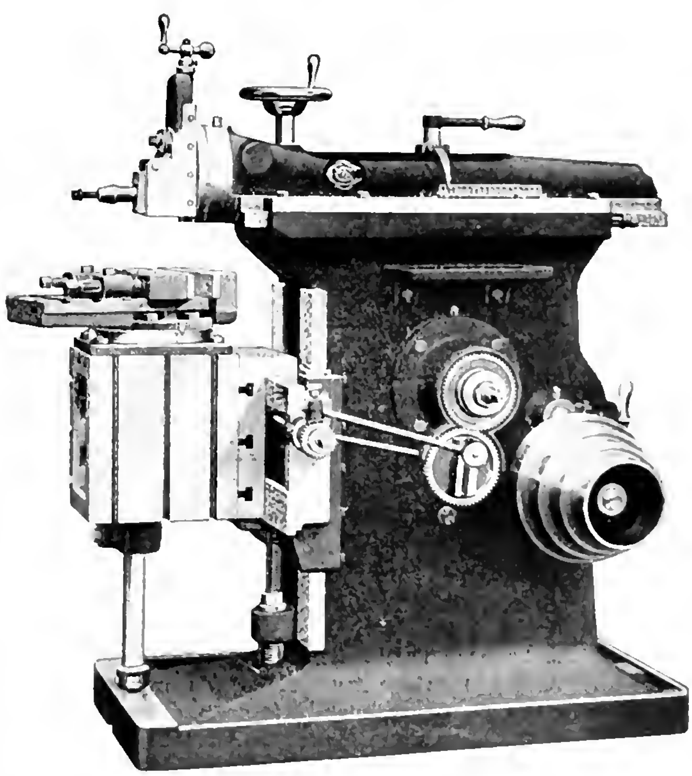
The ram of this shaper may be given eight speeds. It is provided with a bearing in the column 29 inches long by $10\frac{1}{2}$ inches wide, the horns projecting at the front and back of the column allowing this length. The cross traverse screw is provided with a graduated collar reading to .001 of an inch. There are felt wipers between the column and the rail.

The head swivels to any angle and is graduated. The down feed screw is provided with a graduated collar reading to .001 inch. The head is of 8 inches diameter, and may be fed through 7 inches.

The inner end of the main gear journal is twice the diameter of the outer end, thus overcoming any tendency to break at the junction to the gear. The crank block is a steel forging, set well into the cup of the gear, thus permitting the rocker arm to travel close to the edge of the gear and so avoiding overhang.

Full length taper gibs are provided throughout, for the ram, head rail, apron and crank wheel slides, each adjustable endwise by a single screw. The cross feed connecting rod is automatically adjustable to any height of rail and does not depend upon frictional contact. The elevating screw to the rail is of telescopic form, never receding below the floor, and ball bearings are provided for its lower end.

Keyseating of shafting and of simi'ar work, up to 3 inches diameter, is provided for by an opening through the column under the ram. The table is 12 inches long by 11 inches wide. Outer supports, as shown, are furnished. The vise is of double screw form, has a graduated swiveling base, and permits either straight or taper pieces to be clamped readily. The vise opens $8\frac{1}{4}$ inches, and the jaw plates are of annealed tool steel.



Cincinnati Crank Shaper

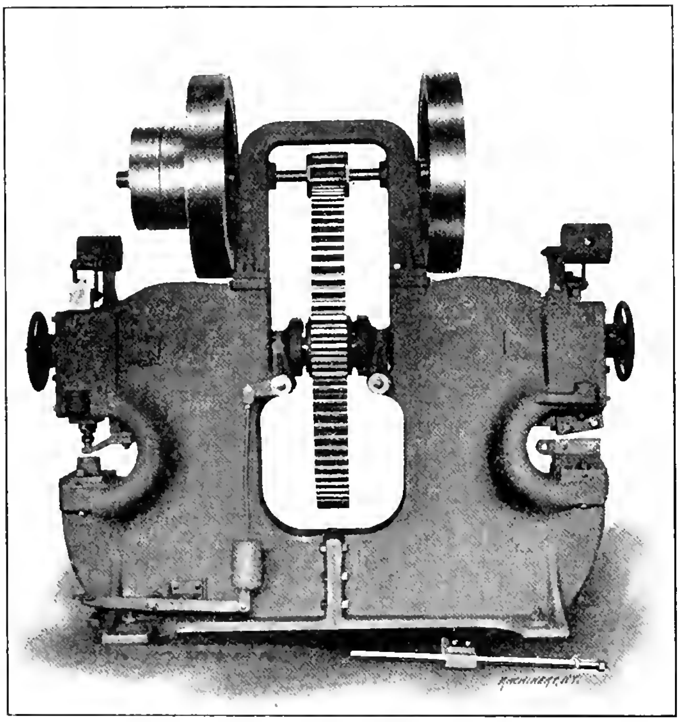
All shafts of the machine are of high point carbon steel, accurately ground; all gears and tee slots are cut from the

solid; all pinions are of cast steel and all bevel gears are cut from the solid bar. All flat sliding surfaces are hand-scraped to surface plates.

The length of the stroke can be changed from the working side of the shaper, and its position by means of a handwheel, shown on top of the ram. These changes can be made while the machine is in motion. The extreme length of stroke is $16\frac{1}{2}$ inches. When the shaper is used single-geared the ratio is six revolutions of the cone shaft to one stroke of the ram. In the back-geared form, the ratio is, as stated above, 24 to 1.

THE DOTY DOUBLE-END PUNCH AND SHEAR.

The accompanying illustration shows a double-end punch and shear recently built by the New Doty Mfg. Co., Janesville, Wis. The machine is seen to be very simple in its design. The main frames are of cast iron of hollow box section. The eccentric shafts are made from open-hearth steel, with the eccentric turned larger than the body of the shaft, thus allowing an extra large bearing in the front cover plate. Eccentric boxes are of bronze, carefully fitted to the sliding heads. These latter are fitted with brass gibs for taking up any wear which may occur.



Doty Double-end Punch and Shear.

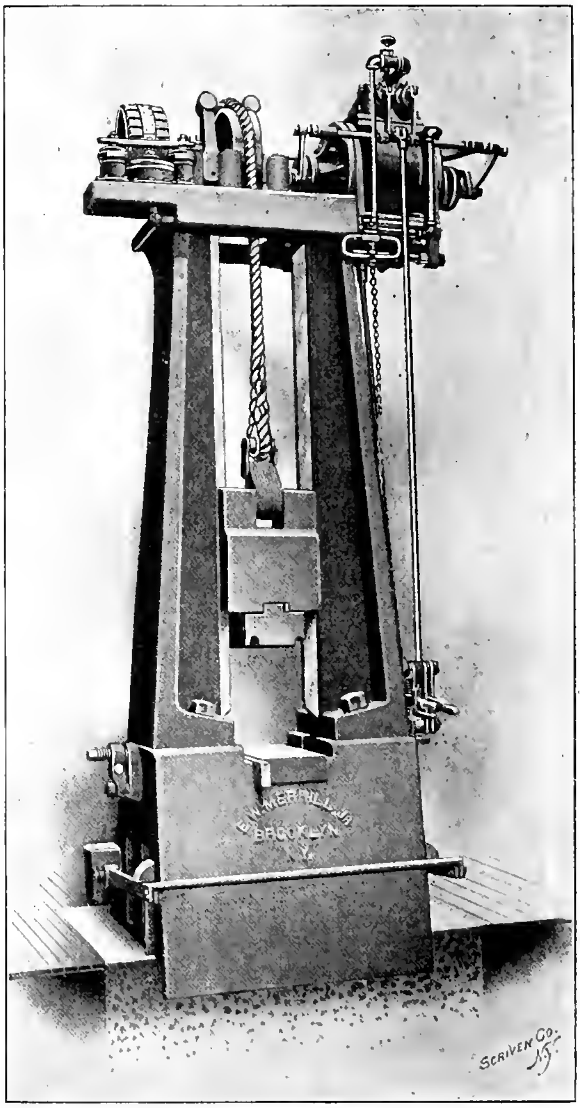
The gear ratio in the Doty punch is seen to be large, and as the flywheels are heavy both ends of the machine may be run continuously. One end of the machine is fitted with punching tools, and the other end with bar shears, but as all classes of tools are interchangeable, this arrangement can be varied as desired.

IMPROVED SEMI-ROTARY STEAM DROP HAMMER.

The accompanying illustration shows the drop hammer manufactured by E. W. Merrill, Jr., Brooklyn, N. Y., as it appears with recent improvements. These consist chiefly in the removal of all trip or hold-up latches, pawls, and falling rods, commonly employed in drop-hammer mechanisms. In their place an automatic brake is applied to the lifting shaft to arrest the hammer the moment the foot of the operator leaves the treadle. By the absence of the working parts mentioned above the hammer is enabled to operate with a nearer approach to noiselessness, and wear and breakages are correspondingly reduced.

The Merrill hammer and lifting device was described in its original form in MACHINERY for January, 1903. As then described the lifting shaft is rotated, through a fraction of a revolution, by a steam or air cylinder at the right end of the shaft. A piston in the cylinder revolves to a certain position, lifting the hammer by means of a rope or strap attached to lifting arms on the piston shaft. At the final piston position the steam or air is allowed to exhaust, the piston returns to its initial position, and the hammer drops by gravity.

The improved lifter holds the hammer suspended at different heights, not by the usual side-latch, as heretofore, but by means of the brake attached to the left-hand end of the lifting shaft. This brake works in conjunction with the main lifting valve, and the instant the lifting shaft stops rotating, the brake is automatically applied, and securely holds the shaft in any desired position. The brake is released at will by a small controlling valve, connected to the treadle by a light chain or rod. By keeping the foot depressed upon the treadle, the hammer will deliver a repeated number of blows until the foot is removed; a single blow can also be gotten. If the treadle is depressed but slightly, a suppressed blow will be delivered.



Improved Merrill Drop Hammer.

If for any reason the supply of steam or compressed air should be turned off, the hammer cannot fall, even should the treadle be depressed, since the steam or air pressure is required to operate the brake controlling valve, before the hammer can fall.

When setting dies, the hammer can be lowered and held permanently suspended in any desired position, or lowered gently until the faces of the dies meet. When the hammer is held at rest in a raised position power is not consumed, as the brake is held in its locking position by compression springs.

The automatic trip may be set at any height between the lowest and highest range of fall by the adjustment of a turnbuckle. This operation may be performed while the hammer is running. The fall may be varied from a drop of six inches up to one of eight feet.

The speed of operation of the hammer depends upon the steam or air pressure. Under ordinary conditions blows will be delivered at the rate of 100 per minute with a 1-foot fall, 75 with a two-foot fall, 60 with a three-foot fall, and greater falls with a proportionately less number of blows.

Heavy hammers are successfully raised by this type of lift. Locomotive forgings weighing 240 pounds each have been formed from the solid with hammers raised in this manner.

These lifters can be placed over any style drop hammer, because the entire operating mechanism is self-contained on the one-bed plate.

NATIONAL TURRET HEAD DRILL CHUCK.

The accompanying half-tone, Fig. 1, shows a turret lathe fitted with a number of the new turret head drill chucks which the Oneida National Chuck Co., Oneida, N. Y., are now

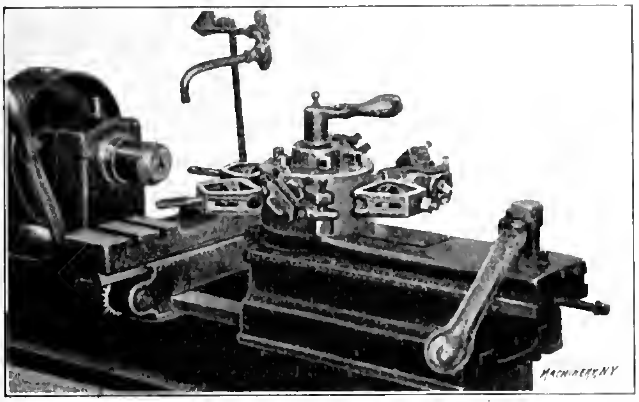


Fig. 1. Lathe with Turret Head Drill Chuck.

making especially for turret head use. One of these chucks is shown in Fig. 2.

The shank of this chuck is made to fit the holder in the turret head. There is a positive drive, in which the end of a

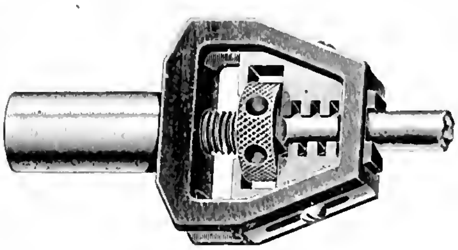


Fig. 2. Turret Head Drill Chuck.

tap or drill is held positively. The flat construction of the chuck allows a larger size to be used in the lathe than otherwise. Its shortness and compact construction are also features.

NEW RIVETT INTERNAL GRINDER.

A new machine designed especially for internal grinding at high speeds of rotation has just been put out by the Faneuil Watch Tool Co., Brighton, Boston, Mass., and is a development of the smaller bench grinder of that firm.

This grinder is designed especially for operation in holes up to 3 inches or 4 inches diameter, although it will swing work as large as 6 inches in diameter. It will also grind to a depth of 6 inches. Its appearance is shown by Fig. 1. The grinding wheel slide may be swiveled to any required angle, and is operated by the handwheel shown at the right front of the cut. The work table, which is also arranged to swivel, has an automatic reciprocating action, and may be traversed by hand through the handwheel shown to the left of the cut, acting through a pinion and rack.

The quill for the grinding wheel spindle embodies the "Rivett" type of bearing, as shown in Fig. 2. In this, end thrust is taken up by the collar centrally located on the spindle. This collar revolves between anti-friction washers abutting against adjustable sleeves. The adjustment of the split bearings is made by means of sleeves which are independently capable of endwise movement through the agency of the opposing screws shown at 1 and 2. Each of these sleeves acts upon three wedges which are concaved at the bottom to fit the box, and which serve to adjust the latter nicely to the spindle, as the sleeve is slid endwise.

The spindle is driven by two elastic belts, through pulleys at each end, as shown in section in Fig. 2, and in perspective in Fig. 1. The speed range secured by the cone pulleys is stated as from 20,000 to 75,000 revolutions of the spindle per minute. The reciprocating mechanism for the table is oper-

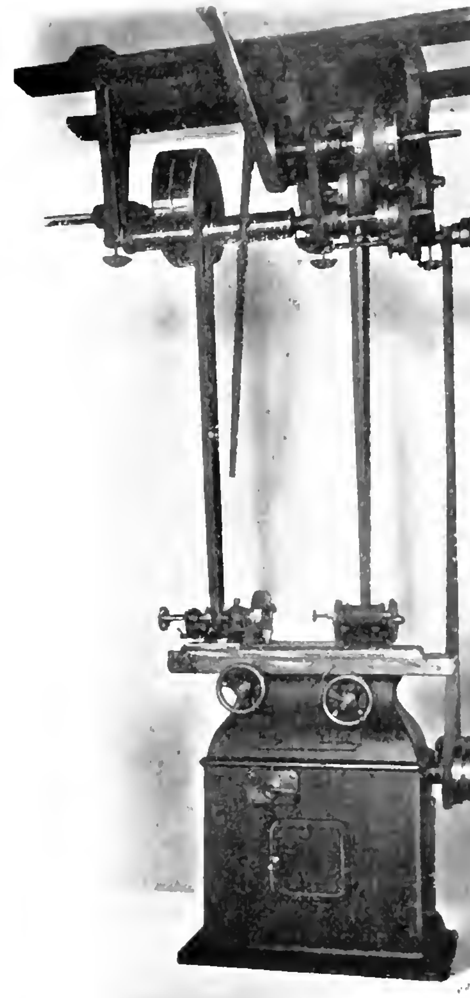


Fig 1 Rivett Internal Grinding Machine.

ated through a heart-shaped cam carried on a vertical shaft, which cam acts on an adjustable contact roll carried by a rocker arm; the roll is held constantly in contact with the cam by springs. The upper end of the rocker arm is joined by a link to a reciprocating block, which may at will be connected to or disconnected from the work-table.

The cam is of considerable depth and tapers from top to bottom. The length of stroke of the work-table may be varied from 0 up to 6 inches by turning the handle shown at the front of the bed of the grinder, in Fig. 1. This is accomplished by means of a shaft, operated by the handle, which shaft, through bevel gears and screws, adjusts the position of

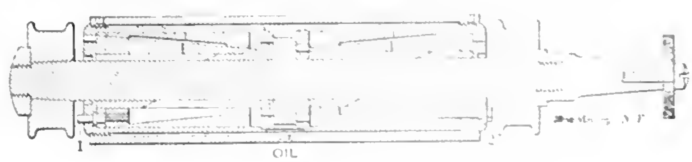


Fig 2. Grinding Wheel Spindle and Bearing

the contact roll carrier along the face of the rocker arm. The cam is so laid out that as the center of the stroke is approached, that is, as the grinding wheel nears the middle of the work the rate of traverse is slightly retarded, the movement being correspondingly accelerated immediately the center point is passed. This counteracts any tendency there may be for the wheel to take a lesser cut at the center of the work

than at the ends, and at the same time allows, in general, a coarser rate of feed to be employed than would otherwise be permissible. The cam, which causes the reciprocation of the bed, is rotated from the four-stepped cone shown at the side of the machine, through bevel and spur gearing. The driving belt passes under two idlers mounted directly back of the cones.

The reciprocating block which drives the table is attached thereto by a clamp, which is held in a slot formed in the under side of the table. This construction is designed to prevent the possibility of springing in any working part of the machine. The table may be stopped at once, without shutting down the machine, by releasing this clamp. It may then be run back by hand for the inspection of the work, or the admission of new work.

A stop (not shown) is provided at the left-hand end of the table to act as a locating medium, so that, after the table has been disconnected from the block and run back, it may again be slid forward exactly to its former position. It may then be again clamped to the block and a cut taken by the wheel to exactly the same depth as before. By means of the stop, also, the table and the work upon it may be given any adjustment desired relative to the grinding wheel.

Fig. 1 shows clearly the arrangement of the overhead shafting and cones by which the velocity of the work and wheel spindles, and the speed of reciprocation of the table, may be varied.

NEW STARRETT TOOLS.

The L. S. Starrett Co., Athol, Mass., have brought out a number of new tools for machinists and toolmakers, three of which are illustrated herewith. In Fig. 1 is a new protractor, which also makes a square, plumb and level. The turret which carries the blade is graduated on both sides, one side in degrees and the other to show the pitch to the foot; and the fact that there are two arms to the square enables the complementary angle to be laid out without calculation, if desired. The sliding blade enables the square to be used in close quarters, where a fixed blade could not be used, and the tool is also adapted for use as a depth gage, under certain conditions.

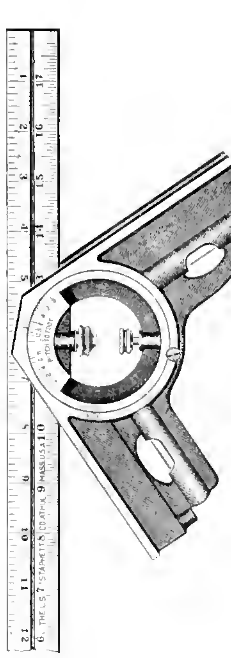


Fig. 1. Protractor.

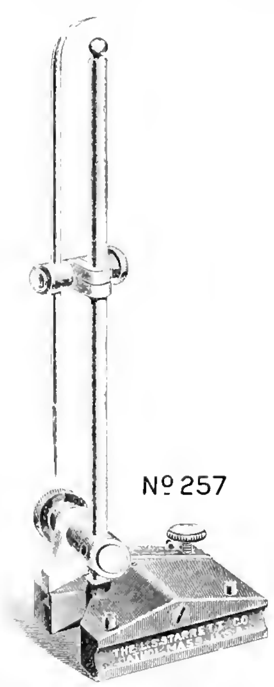


Fig. 3. Universal Surface Gage.

In Fig. 2 is shown a pair of keyseat clamps, designed to transform any steel scale into a keyseat rule. The clamps are made from steel, casehardened and accurately ground.

In Fig. 3 is a new universal surface gage, with casehardened steel base. The base is grooved through the bottom and end, adapting it for use on or against circular work as well as flat surfaces. The spindle passes through a rotating head jointed to a rocking bracket pivoted in the base. The bracket is adjusted by a knurled screw which acts against a stiff spring. The spindle may be set upright or at any angle, or turned so as to work under the base, and can be delicately adjusted to any position. The scriber is carried by a swiveling head. In the base are four gage pins which can be pushed out to bear against the edge of a surface plate or the side of a planer slot for linear work. The spindle may be removed if desired and the scriber inserted in a hole provided for it for small work.

In their catalogue No. 17 D, describing the new tools re-

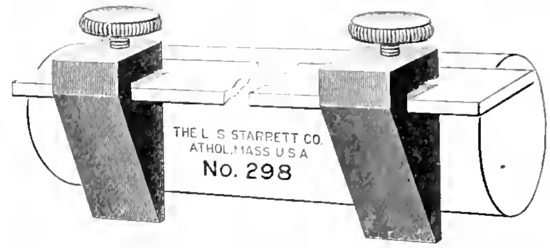


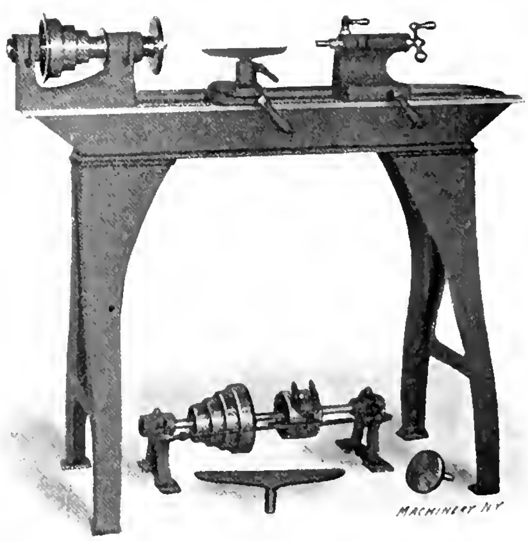
Fig. 2. Keyseat Clamps.

cently brought out by this company are a large number of new micrometer calipers which are put up in sets, to measure from 1 to 6 inches. These sets are arranged in various combinations, containing a greater or less number of micrometers, as desired. Numerous other small tools are shown, such as a small tap wrench, nippers, pocket screw drivers, pin vises, etc.

TEN-INCH "STAR" WOOD-TURNING LATHE.

We show in the accompanying cut the 10-inch "Star" wood-turning lathe of a new design which has just been placed on the market. This lathe is especially suited for use in manual training schools. Its rated size is 10 inches, but it has an actual swing of 11 inches over ways and 7 inches over hand rest.

The lathe is fitted with a hollow spindle (with 17-32 inch hole), made from a crucible steel forging, which runs in large phosphor bronze bearings which are dust-proof and self-oiling. The cone pulley has four steps, and is turned inside as well as outside.



Star Wood Turning Lathe.

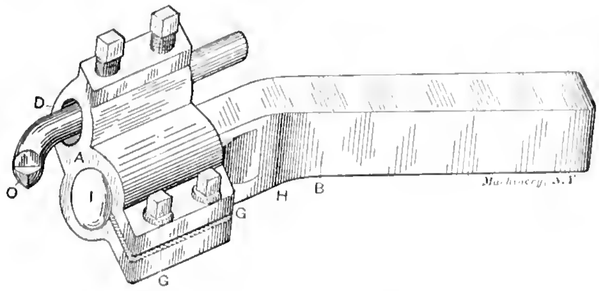
The tailstock is the cut-under pattern, has a long bearing on the ways and is firmly locked to the bed by a convenient lever. The tailstock spindle is locked by an improved locking device. The hand rest has long and short T-rests. The rest socket and saddle are locked to the bed by a cam locking device and the T-rest is held in socket by a friction clamp, thus doing away with the setscrew commonly used. Both are operated by levers.

The bed is made in two lengths, four and five feet long. The front way is flat and the back way is V-shaped. The countershaft has self-oiling and self-aligning shaft bearings, four-step cone and tight and loose pulleys. Faceplate, screw-chuck, cup and spur centers are furnished with each lathe and when desired a slide rest for metal turning.

This lathe is manufactured by the Seneca Falls Mfg. Company, 330 Water Street, Seneca Falls, N. Y.

ADJUSTABLE TOOL-HOLDER.

The adjustable tool-holder illustrated herewith, the invention of J. X. Mathieu and J. F. Pullan, Great Barrington, Mass., provides a device for holding boring tools whereby the latter can be set to the exact length required for the depth of the hole to be bored. By its use also the boring tool can be readily raised or lowered, and brought to its point of application, without losing its horizontal position, by rotating the head, *A*, on the cylindrical portion, *I*, of the shank, *B*. The advantage of keeping the tool parallel to the axis of the hole, especially in boring holes of small diameter, is obvious, as



Adjustable Tool-holder.

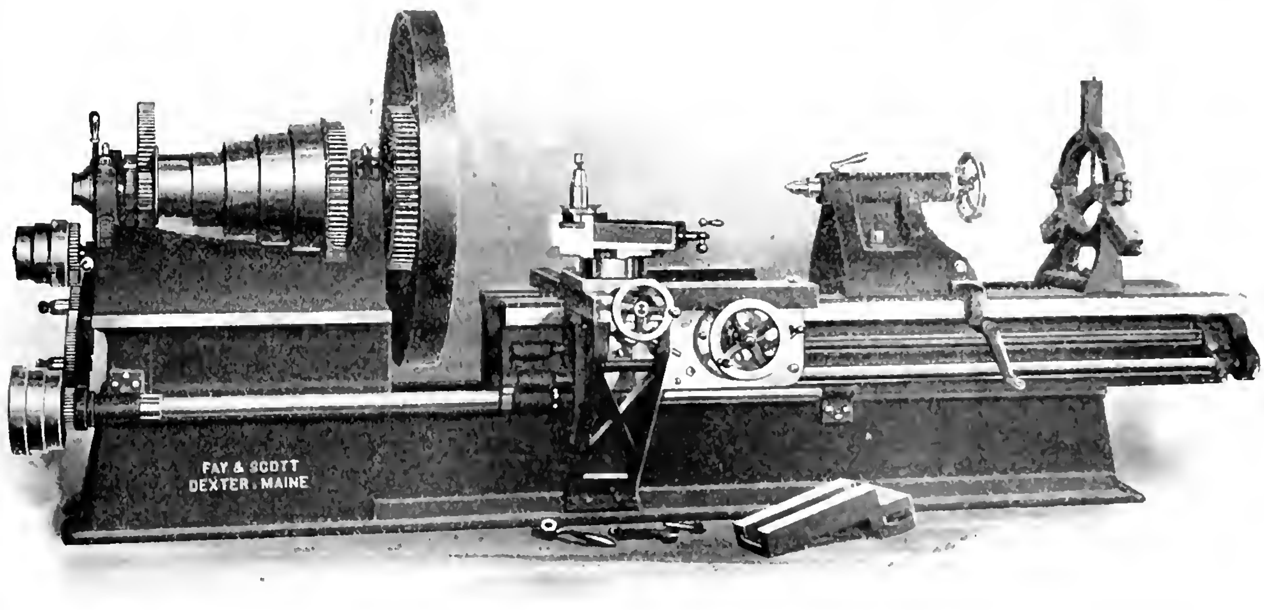
otherwise the largest possible tool could not be used without interfering with the work during the advancement of the tool.

The construction of the tool-holder is evident from the figure. The shank, *B*, of the holder is held in the chuck or tool stock of the lathe. The head, *A*, which carries the cutter 0 securely setscrewed in opening, *D*, is placed on the cylindrical end of the shank of the holder, and clamped to any desired distance above or below the holder, by means of clamp screws, *G*. The shank of the holder is bent, as shown at *H*, so that the tail of the cutting tool may be thrown clear of the tool stock, and the head allowed to rotate without interference.

The holders are intended to be made in two sizes, the larger for engine lathe, and the smaller for bench, or precision lathe, work.

EXTENSION GAP LATHE.

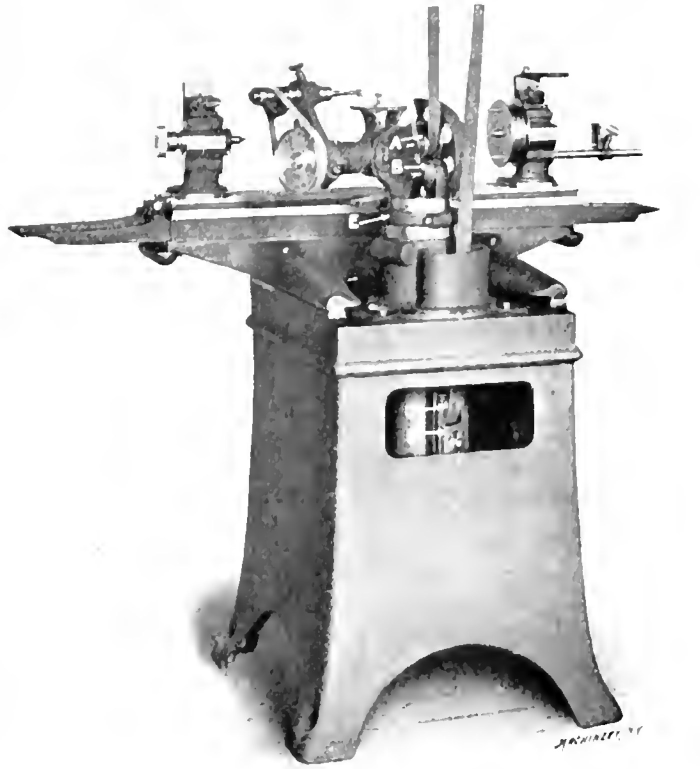
Fay & Scott, Dexter, Maine, are the makers of the extension gap engine lathe illustrated herewith. This lathe is triple geared direct to faceplate, the triple gear ratio being 34 to 1. The carriage is extended for turning work with the full swing of the lathe, and is supported by an angle bracket, with an adjustable gib on the lower bed. The lathe swings over the bed 28 inches, and through the gap 52 inches. The 12-foot lathe made takes 6½ feet between centers closed, and 10½ feet extended. The gap opens 4 feet, and every additional foot of bed lengthens the gap by 6 inches.



Extension Gap Lathe.

IMPROVED DESIGN OF WALKER GRINDING MACHINE.

The accompanying illustration shows the present improved form of the Walker tool room grinder, which was described in MACHINERY for August, 1904. The machine as there illustrated was a universal grinder which combined considerable range of operation with freedom from complexity.



Improved Universal Grinder

An important feature was the arrangement of grinding spindle, wheel post and housing, whereby the spindle could be raised and lowered, and swiveled horizontally and vertically, without affecting the tension of the belt. The changes made consist in an improved design of column for the grinder, but more particularly in an enlarged and improved wheel post and housing, whereby one leg of the belt passes down through the post and around a stationary idler, instead of being outside the housing, as in the previous construction. The range of performance of the grinder remains the same. An improved automatic feed device has also been provided.

In the illustration given, a rear view of the grinder, the method of belting is seen. The down leading side of the belt passes under the upper idler, *A*, around the grinding spindle, over idler *B*, thence down inside the hollow wheel

post and under idler *C*, whence it returns through the opening in the housing, as shown. The idler *C* is journaled in bearings in the vertical slide, *D*, as seen through the opening in the column, by means of which any stretch of the belt may be taken up. No adjustments of this idler are necessary for the ordinary operation of the machine, since the power is all delivered from the down side of the belt, and the spindle is made to raise and lower without varying the belt tension. The down leading side of the belt above the spindle coincides with the axis about which the housing swings, and therefore the running of the belt is not affected by the angular adjustments of the housing. The idler *C* swivels with the housing, and the belt runs in partial or full quarter turn, as the case may be.

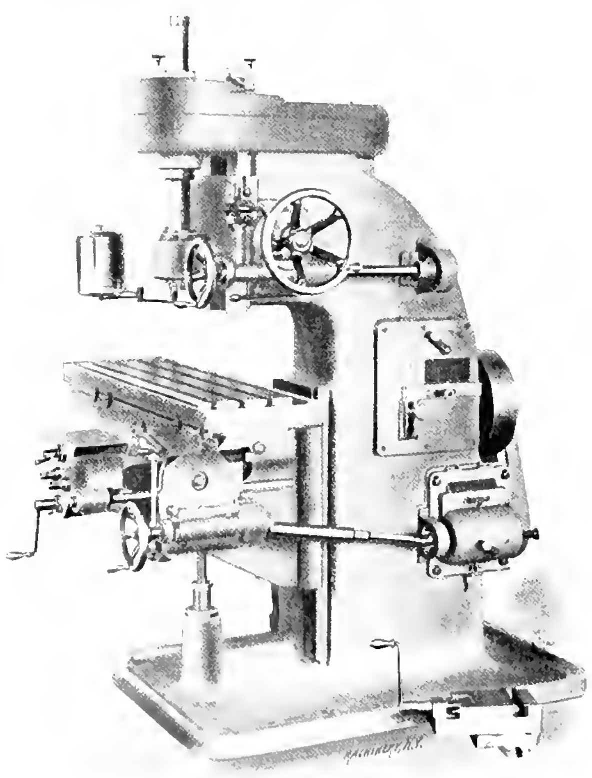
The wheel post is raised or lowered by means of an elevating screw, a pair of miter gears and a horizontal shaft ending in a handwheel on the front of the machine. This horizontal shaft is journaled in a bracket which is free to swivel about the hub at the lower end of the wheel post housing.

A further improvement in the present machine consists in means for setting the milling cutter tooth rest to height without the use of gages. A tooth rest bracket is provided, which, as shown at *E*, rests on top of the housing and is faced off to bring it to the exact height.

The machine is made by the Walker Grinder Co., Worcester, Mass.

NEW BROWN & SHARPE VERTICAL MILLER.

The Brown & Sharpe Mfg. Co., Providence, R. I., have made an addition to their line of vertical spindle milling machines, a tool embodying a number of very interesting features. It is very attractive in appearance, as well, as is evidenced by the accompanying illustration.



New Brown & Sharpe Miller.

A constant speed drive is used in this machine, the cones being done away with. A single 14-inch pulley is used, belted to a countershaft to run constantly at 310 revolutions per minute. The drive is direct from the vertical driving shaft to the vertical spindle by chain and sprocket wheels, insuring a positive drive; the variable speed of the spindle is obtained by gearing that has a ratio of from 1 to 1 up to 18 to 1. Sixteen changes of speed are thus given, or from 17 to 354 revolutions per minute in either direction. The drive can very easily be from a constant-speed motor instead of from the belt pulley, finished bosses being provided on the back of the machine for the attachment of a motor.

The variations of spindle speeds are in geometrical progression, and are controlled by the movement of a lever and index slide on the side of the machine. To change the speed the lever is unlatched, and moved down as far as it will go, when the index slide is moved nntil it is opposite the column on the speed plate corresponding to the desired speed. The lever is then moved up, and the locking pin engaged with the proper hole, when the correct gears will be in mesh. The lever over the plate gives two series of speeds, one fast and the other slow.

The spindle is of crucible steel with bronze boxes, the lower of which is provided with means for taking up wear. The lower end of the spindle is threaded to receive a large cutter or a chuck, and has a taper hole. A recess across the end provides for positively locking any arbor or collet that has a clutch collar. The arbors and collets are held in place by a drawing-in bolt that passes through the spindle.

The spindle head has a vertical movement with fine hand feed and a quick return; also an automatic feed for drilling work already in position for milling. The feed is automatically released at any point, a micrometer stop being provided to regnlate the depth of cut. The head is counterbalanced by weights inside the column.

The table is provided with a quick return obtained through a coarse-pitch screw. To utilize it, the feed worm is disengaged and the crank shown on the face of the knee turned. A slow and powerful hand feed in either direction is given by the handwheel at the right of the machine, which connects with the worm and wormwheel. Ball thrusts are provided for the feed worm and elevating screw, which latter is of the telescopic pattern.

Table feeds are automatic in either direction and can be automatically released at any point, when the table will be locked in that position. With the table feed locked, the power cross feed or vertical feed can be used. The table feed screw is not splined.

The feed mechanism is newly designed, and consists of a chain and sprocket drive from the machine pulley shaft to the feed case, with no intermediate gearing. The feed is thus positive. The gears in the feed case, driven by the chain, are all spur gears, there being 12 changes, varying in geometrical progression from 1½ inches to 17 inches per minute. This method of driving gives a table feed that is independent of the spindle speed, and also a fixed rate of feed, in inches per minute, as shown on the feed index plate. For small mills a range of from .004 inch to .048 inch, and for large mills from .088 inch to 1.000 inch is given per revolution of spindle. To change the feed, it is only necessary to withdraw the locking pin of the lever shown at the right of the feed case, and move up the lever as far as possible; tho index slide underneath the table of feeds is then moved opposite the column containing the required feed; the lever is then moved down and the locking pin will drop into the proper hole. The short lever at the bottom of the case gives two series of speeds, one fast and one slow.

The working surface of the table is 42 by 12 inches. The greatest distance between the top of the table and the end of the spindle is 23 inches, the knee having a vertical adjustment and automatic vertical feed of 15 inches, and the spindle head of 8 inches. The automatic longitudinal feed is 34 inches and the transverse 13½ inches.

TOLEDO REDUCING PRESS.

The Toledo Machine & Tool Co., Toledo, O., have recently completed what they claim to be one of the largest and most powerful single pitman straight-sided, cutting, forming and reducing presses ever built. It was designed especially for drawing and reducing metal ⅜ and ¼ inch in thickness for large wagon hnbs, valve seats, etc., and also for stamping and embossing.

The clutch mechanism is automatic, and of the three-engagement sliding block type, being controlled by a gravity releasing attachment. The crankshaft is 13 inches in diameter at the crank bearing; the stroke is 14 inches.

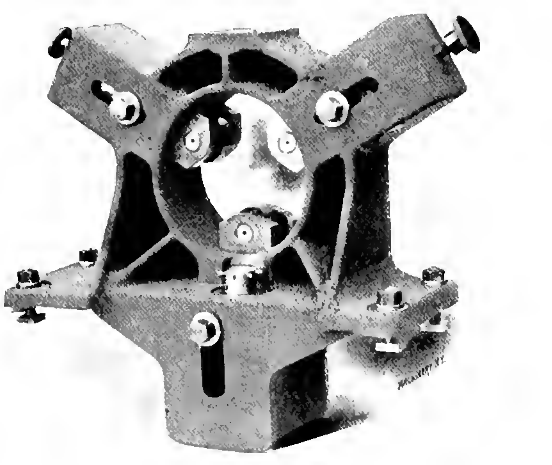
The shaft and connection screw are of high-carbon open-

hearth steel forgings. The connection screw for slide adjustment has a right and left-hand thread and is held in position by caps on the upper and lower connections, having a perfect bearing directly on the threads of the screw and securely clamped by means of four studs in each cap. The press is geared 1 to 15, the large gear having a 14-inch face, the teeth being three-fourths diametral pitch. All gears are machine-cut from the solid.

The width between uprights is 38 inches and the area of bed is 38 by 38 inches; the length of slide bearings, 55 inches, and the complete weight of the machine about 95,000 pounds.

HIGH-SPEED FOLLOWER REST.

In the work of roughing bars of even as great as 8 inches diameter some substantial support, such as a follower rest, is needed to obtain the best results from the use of high-speed steels. The illustration herewith shows a follower rest, the invention of the Lodge & Shipley Mche. Tool Co., Cincinnati, O. The company state that after using several different metals for the jaws of such a follower rest, only to have them cut out, they hit upon the roller plan, clearly shown in the half tone. The rollers are of hardened tool steel and are mounted upon hardened and ground steel shafts, upon which they are fixed by screws through the faces of the rollers.



High-speed Follower Rest.

Liberal provision is made for oiling the journals of the roller shafts. A sensitive adjustment for the jaws is provided by the knurled knobs, so that they cannot be forced down too tightly. Provision is also made, at an extra charge, for special cases, so that the pad at the top of the rest can be planed and an angle bracket carried from this to attach to the wings of the carriage on the opposite side, to insure great stiffness and rigidity. So arranged, they say that the results obtainable on heavy bars, from one of their high-speed lathes, can be doubled over the results from the same lathe without such a rest.

* * *

FRESH FROM THE PRESS.

American Toolmaking and Interchangeable Manufacturing. By Joseph V. Woodworth. Published by the Norman W. Henley Pub. Co., 132 Nassau St., New York. 535 8-vo. pages. Illustrated. Price $4.00.

Mr. Woodworth is a toolmaker by trade and has devoted much attention to jigs, fixtures and special devices and appliances for reducing the cost of manufacturing. He has been a frequent contributor to mechanical papers, upon these and allied subjects. In preparing the present volume he has drawn upon information that he has gathered and presented in some 300 contributions to various papers, editing and revising the matter so as to adapt it for a treatise upon improved processes of manufacturing. The volume is illustrated by 600 engravings, made especially for the work, and the typography and press work are good, making an attractive book. The matter is arranged systematically in 33 chapters, treating of subjects related to one another so that it is convenient to have them grouped for reference. Five chapters treat of drilling jigs for various grades of work; milling machine fixtures are treated under four chapter headings; turret lathe tools and fixtures, screw machine tools and boring machine tools each have a chapter; the design and manufacture of milling cutters, the hardening and tempering of such cutters and the making of drills, forming tools, etc., are treated.

In addition to the above there are a number of special lines of work properly coming under the title of the book, which receive attention. These are broaches and broaching; punches and dies; with a somewhat extended treatment of sheet metal work; engraving, the sinking and the use of dies for medals, jewelry and art goods; and finally the process of swaging and the use of swaging machines.

The foregoing titles give a fair idea of the scope of the work, and the seeker after information upon shop processes will find, in addition to the above, that considerable data has been gathered on novel methods for metal working, not commonly known, including processes for working aluminum. The author has made a careful and systematic study of machine shop manufacturing operations, extending over a period of a number of years, and his text book cannot fail to interest persons connected with shops where modern methods of interchangeable manufacturing are in vogue.

NEW TRADE LITERATURE.

Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes.

Joseph Dixon Crucible Co., Jersey City, N. J. Advertising card calling attention to Dixon's flake graphite for the lubrication of air compressors.

The Adams Co., Dubuque, Iowa. Illustrated catalogue describing the "Adams-Farwell" motor car, recently shown in the columns of Machinery.

The Desmond-Stephan Mfg. Co., Urbana, O. Pamphlet treating of the "Desmond" diamo-carbo emery wheel dressers for truing and shaping grinding wheels.

The Lucas Machine Tool Co., Cleveland, O. Circulars describing the No. 1 "Precision" boring, drilling and milling machine and the Lucas power forcing press.

The Rand Drill Co., 128 Broadway, New York. Circular No. 14 of the "Imperial" pneumatic hammers, piston air drills and air compressors of their manufacture.

The Electric Controller & Supply Co., Cleveland, O. Bulletins Nos. 1004 and 1010 treating respectively of solenoids and electro-magnets, and of magnetic switches.

Brown & Sharpe Mfg. Co., Providence, R. I. "Accuracy Measuring Tools," a little pamphlet showing the measuring tools of this company which were exhibited at St. Louis.

The F. Bissell Co., Toledo, O. Circulars of the "Acme" metal saw, the "Security" induction sparker for gas and gasoline engines, Bryan-Marsh Imperial lamps for electric lighting purposes, etc.

The Seattle Machine Works, Seattle, Wash. Circular of the "Paulson" pump cylinder reducing sleeve, designed especially for converting a standard steam boiler feed pump into a high-duty pump.

The Pedrick-Smith Co., Philadelphia, Pa. Unique little catalogue in the form of a punch, showing the punches, dies, punch couplings, etc., made. A list of sizes of each product is given, and some tables also appear.

The Colburn Machine Tool Co., Franklin, Pa. Catalogues descriptive of their 53-inch vertical boring and turning mill, and of their 72-inch widened pattern vertical boring mill, described in our December issue.

The D. M. Stewarn Mfg. Co., Chattanooga, Tenn. Circular calling attention to the company's "Compo" and Soapstone marking crayons, for marking car trucks, freight cars, and for a great variety of other purposes.

The Bessemer Gas Engine Co., Grove City, Pa. Illustrated catalogue of the Bessemer gas engines, gas cylinders and roller pumping powers. A description of each of these products appears, accompanied by many fine half-tone engravings.

The Newhall Chain Forge & Iron Co., New York. Catalogue No. 185, dealing with the "Warwick" chain for all purposes where chain is used, such as for crane work, dredging, steam shovels, ship cables, conveying, mining, quarrying, etc.

The Moline Tool Co., Moline, Ill. Catalogue No. 1 showing five sizes of gang drills, an automatic screw driving machine, a head borer, a double-end bolt cutter, the R. & V. speed lathe, the R. & V. countershaft, and a gang borer, with short descriptions of each.

The General Pneumatic Tool Co., Montour Falls, N. Y. Bulletin No. 56, descriptive of the electric hoist of their manufacture. Other bulletins treat of their portable compression riveter; column riveting machine; combined stationary and portable riveter; and pneumatic motor hoists.

The Northern Engineering Works, Detroit, Mich. Booklet No. 19, of cranes. These include electric, hand, and air-hoist traveling cranes; jib cranes, electric, pneumatic and band; truck cranes, pillar cranes; locomotive, bracket jib and gantry cranes, illustrated by about twenty-six cuts.

The L. S. Starrett Co., Athol, Mass. Supplement to catalogue No. 17D, showing some of the Starrett tools, among which we note a patent protractor No. 16, a keyseat clamp, a tap wrench, a double-lip countersink, a new desk rule, new universal surface gage, a line of new micrometers from 1 to 6 inches, etc.

The Reed Mfg. Co., Erie, Pa. Catalogue F of the Reed products. These include stocks, with adjustable and with solid dies; pipe vises, combination vises, pipe cutter wheels, pipe reamers and taps, combination drill and tap, combination pliers, pipe wrenches, the "Economy" oil cup, etc. Some useful tables and other information also appear.

The Ohio Pulley Co., Marion, O. Illustrated catalogue, pocket size, of the Buckeye wood split pulleys. All pulleys are bored to a large standard size and with this company's interchangeable wood bushing system each pulley will fit any size shaft up to its standard bore. The various sizes of pulleys are here shown and described and a very complete price list given.

The Dreses Machine Tool Co., Cincinnati, O. Small catalogue of the "Simplex" radial drills. The chief features of this type of tool are here described, then follow illustrations of four sizes of this tool, with specifications; also cuts of their combination tilting table with worm movement, their speed variator, and their constant-speed and variable-speed motor drive.

The Springfield Machine Tool Co., Springfield, O. Illustrated loose-leaf catalogue, 1905, of machine tools. This book is 9 x 12 inches, and contains, printed on heavy coated paper, illustrations of their engine lathes, a turret lathe, shafting lathe, several sizes of crank shapers, a spindle and axle boring machine, two special turret lathes, two sizes of power presses, etc., with full description of each.

The Goodell-Pratt Co., Greenfield, Mass. Catalogue No. 7, 1905, of small tools. Besides the regular line of tools to be found in their previous catalogues a very large number of new tools are here shown, and also a number of old ones that have been changed and improved. This book is standard size and contains 176 pages, all devoted to the illustration and description of this extensive line of tools.

Baker Bros., Toledo, O. Catalogue No. 4B of drilling, boring and tapping machinery. Several sizes and styles of tapping machines and heavy manufacturing drill presses are shown; also a two-spindle locomotive rod boring machine, which is built in three sizes, and a car-wheel boring machine. A review of this catalogue will show the recent improvements which have been made on this company's machines, considerably increasing the capacity of these tools.

The Dodge Mfg. Co., Mishawaka, Ind. "The Construction of a Modern Cement Plant." This is a book 9 x 12, consisting of 75 pages, and treating the subject of cement plants. There are a large number of half-tone views of various cement plants in which is installed the transmission machinery of the Dodge Company. This book is not for indiscriminate distribution, but to those who are genuinely interested a copy will be sent free upon request.

MACHINERY.

March, 1905.

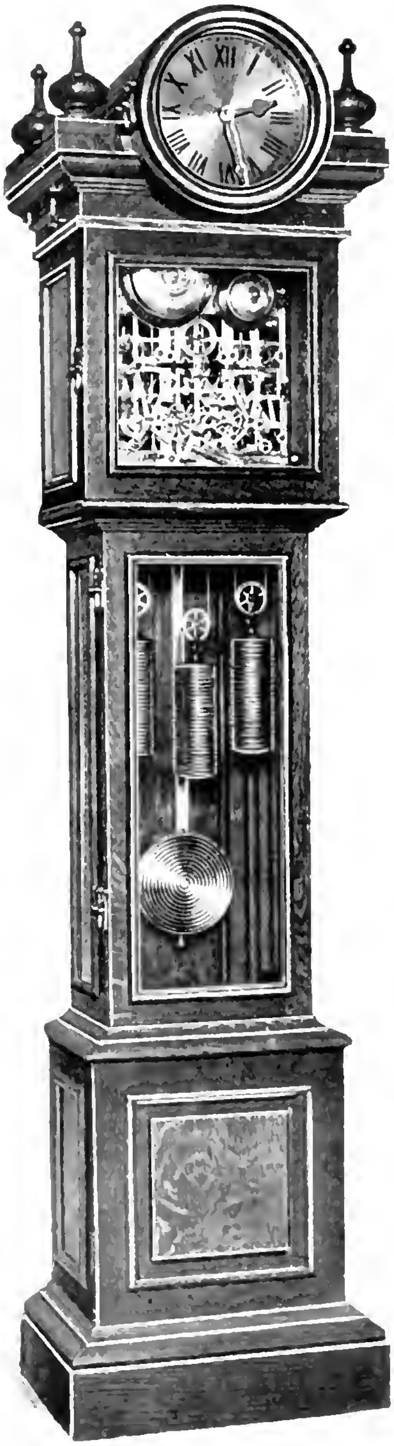
A FIVE MINUTE REPEATER CLOCK.

JAMES ARTHUR.

James Arthur.

In MACHINERY for November, 1901, was presented a description of a Remontoir clock which attracted much attention, being republished several times in other journals. The clock here shown is also of the writer's design, though it might be well to state that this is not a part of the business of the Arthur Company, but merely a personal hobby and amusement of my own, and that no clocks are made for sale. This is the seventeenth complete clock which I have built, and I consider the design of cases in connection with the various styles of movement as of primary importance. In other words, the case and movement must harmonize so as to produce a perfect clock. Horology is, to my thinking, one of the most scientific amusements, since it implies some knowledge of mechanics, mathematics, and astronomy, as well as many minor sciences. One of the most important phases of the subject is the fact that the modern machine tool builder rarely acknowledges his indebtedness to the ancient clock and watchmaker; for the working and tempering of steel, hammering of brass, bearings, friction, oils, springs, gear teeth, etc., had reached a high pitch generations before the era of tho modern tool builder. Take one example: Any smart young fellow knows that when it is necessary to drill a hole through a long piece, like a rifle barrel, the piece must rotate while the drill is held fast, and that the tendency of the drill is to follow the center line of rotation. Now the ancient clockmaker used the "drill and bow," but when he wished to drill a hole through a long piece, like the hub of a "cannon pinion," he caught the "long drill" in the vise and rotated the piece with the bow. The cannon pinion is so called because it has a long hub like a small cannon. Some of these days a book may be added to the numerous works on horology, showing the inventions and discoveries of the clockmaker side by side with modern mechanical practice. An exhaustive work of this kind would take most of the pride out of the present machine constructor.

JAMES ARTHUR, born in 1842, was trained in his father's shop to millwright work, machine work, patternmaking, etc., but when twenty-two he decided on a wider field and spent seven years in the Glasgow Locomotive Works, Scotland. In 1870-71 he took the course in mathematics, mechanics, light, heat and sound under Prof. A. S. Herschel in the "Science and Art Department" of the Andersonian University in Glasgow, Scotland. The professor is a son of Sir John and grandson of Sir William Herschel, the great astronomers. Mr. Arthur received a "Queen's prize" and also has the usual certificates of the department for the separate subjects, but values most highly several scientific books presented to him by the professor and inscribed in his handwriting. He came to the United States in 1871 and within a year was manager of the steam pump and machine works of Adam Carr, New York, and during his seven years there took out a number of patents, some of them jointly with Mr. Carr. In 1878 he branched off for himself and took a partner; then later a special partner, and finally in 1885 he purchased all interests and formed the present style: "The Arthur Co." machine works. This is one of the successful "close corporations," and is wholly owned by Mr. Arthur and his two sons. He has generally confined his inventions and special machines to his own business, and is still active at 63 years.



The Arthur Five-minute Repeater Clock. This Clock strikes the hour automatically, and the hour and minutes in multiples of five any time between, when desired

The general view of the five-minute repeater, taken from a photograph, shows the complete clock, the case being solid oak. What would usually be the face of the clock shows the movement in skeleton framework, and by opening the door the whole mechanism of the clock is as easily got at as if standing on the table. From this movement a vertical shaft goes up to operate the dial work. The dial is brass and has heavy gothic numerals and very distinct hands, which make the clock easily read, although the dial is only 9 inches in diameter. The left weight actuates the hour strike, the middle one the time, and the right-hand one the five-minute strike. The clock is called a "Five-Minute Repeater" because it will repeat the time to within five minutes as often as you pull the cord attached to it; but if let alone it is silent and simply shows the time by the dial and hands. The cord attached may be branched off and have an ordinary bell-pull at every bed in the house, so that any one can have the clock repeat the time during the night. On a deep-toned bell it strikes the last hour, followed on a high-toned bell by a blow for every five minutes past that hour. When it strikes the hour only, then you know that it is less than five minutes past. For instance, suppose it strikes "FIVE-five," then the last hour was five, and five times five minutes past, giving 5:25. But there is another way of considering the matter. The large bell gives the figure which the hour hand has passed, and the small bell the figure which the minute hand has passed, thus making a picture on your mind just as if you had looked at the face of the clock. This will be plain when you remember that in looking at a clock or watch you generally get a mental impression of the time for your own use. This is proved by the fact that if any one asks you for the time just after you have looked for yourself, you will look again and give hours and minutes.

It would be impracticable, in a reasonable space, to show all parts of this clock; therefore, bearings, supports, guides, brackets, etc., are left out in many cases, showing only the essential parts of the construction. In Fig. 2 *A* represents the framework of the movement, 11½ inches square, the front plate in three sections and cut out as shown. The back plate is a solid piece and has the nineteen pillars, *B*, etc., riveted in fast. The advantages of this style of framework in building and adjusting, and in future for cleaning and repairing, are evident, as the clock has a complete train of wheels for each rotations of the scape wheel, shown in full black, per hour for the seconds dial. This hour wheel drives a pinion *D* of 15 teeth, so that *D* rotates in ten minutes. On this ten-minute axle is a 12-tooth pinion, driving a 60-tooth crown wheel *E* on the vertical shaft *F* which goes up to the head of the clock, and which by a pair of bevel wheels of 50 and 60 teeth gives the hour axle of the dial. That is, commencing with the hour wheel in the movement, we have $\frac{90 \times 12 \times 50}{15 \times 60 \times 60}$ = unity, or one

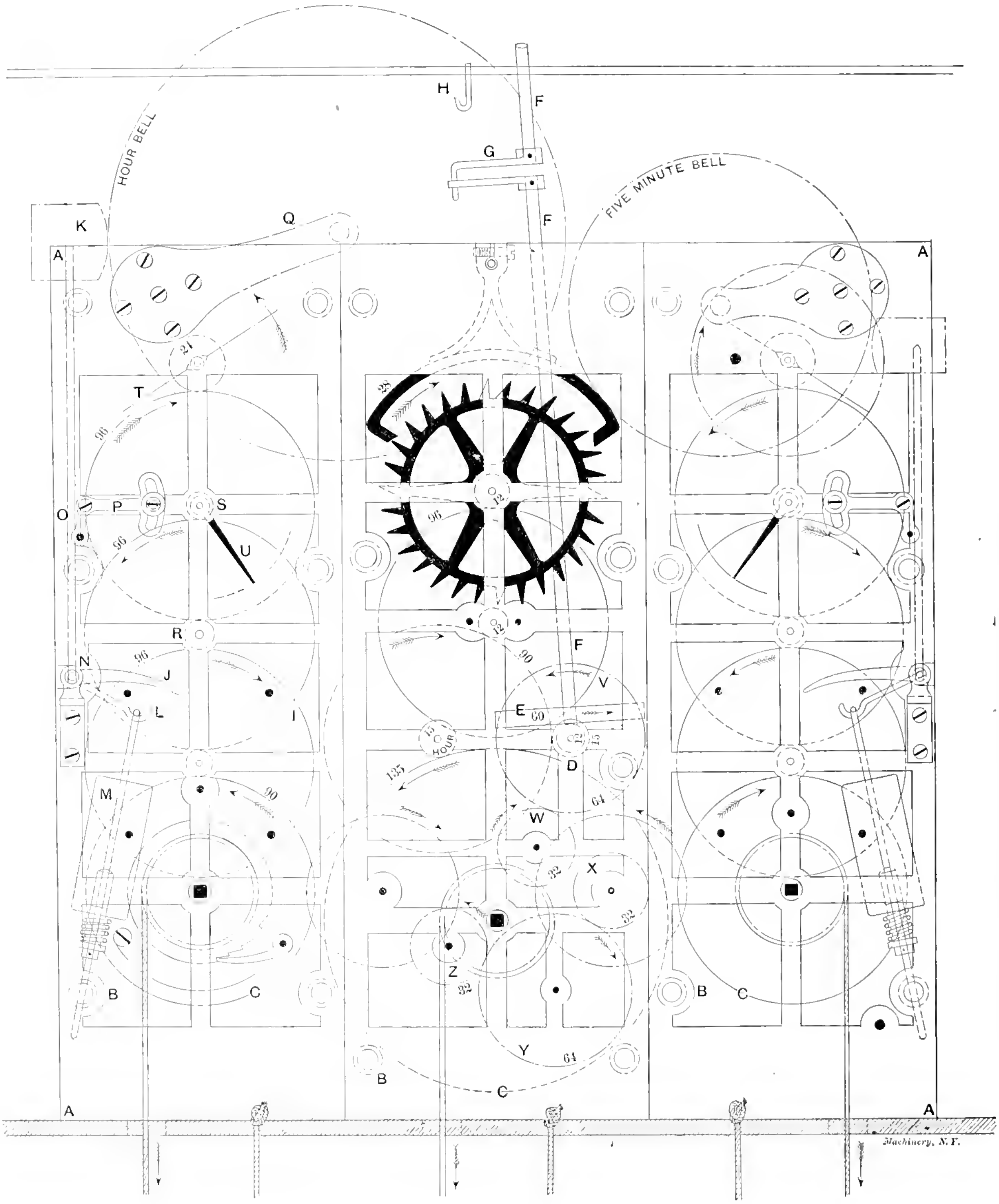


Fig 2. Showing Escapement and Arrangement of the Wheel Trains.

section. The great wheels, *C*, all have barrels and ratchets as shown on the one to the left. Wire cords pass down to the three weights as shown. The center section is the "time train," and as numbers of teeth are marked, it requires no explanation, except that all calculations start from the axle marked *HOUR*, rotating in one hour, so we have $\frac{90 \times 96}{12 \times 12} = 60$ hour, for the center axle in the head of the clock. Behind the dial the usual cluster gives the correct ratio to the hands. It will be seen that the vertical shaft *F* is broken by a crank at *G*, the lower half of which is slotted to take the upper half *G*. The lower part of this shaft *F* works in bearings in the frame and belongs to the movement of the clock, while the upper portion with its half-crank *G* belongs to the head of the clock, the cross bar *H* fastened to the case being its lower

bearing. This portion of F slides easily upward so that half-crank G can be placed in the hook near H, thus making it as easy to lift the movement out of the case as if shaft F did not exist. Further, this break in F is an expansion joint as well as taking the variations in the case caused by damp or dry air, and is therefore a little thing of importance.

Where an open circle is shown as a center it generally means a bearing or pivot, but where a solid black center is shown it means a stud riveted or driven in solid. Looking to the left or hour striking train, it will be seen that wheel I has eight pins which lift the tail J and therefore the hammer K. The arm L as well as the hammer stem O and the tail cock or bracket Q, and is 6 inches diameter, 2 inches deep by ⅛ inch thick, and of bell metal; the five-minute bell is 4 inches diameter but otherwise the same, and has a high tone easily distinguished from the hour bell. The 96-tooth wheel I drives a pinion of 12 eight times, therefore R makes one turn for each blow struck. Axle S makes eight turns per blow, but this is not important so long as it makes some integral number per blow, as will become plain later in connection with arm U. The train ends in the fly T which regulates the speed of striking. Up to this point the train for the five-minute strike on the right side of the figure is the same as described for the hour, but this covers only the elementary

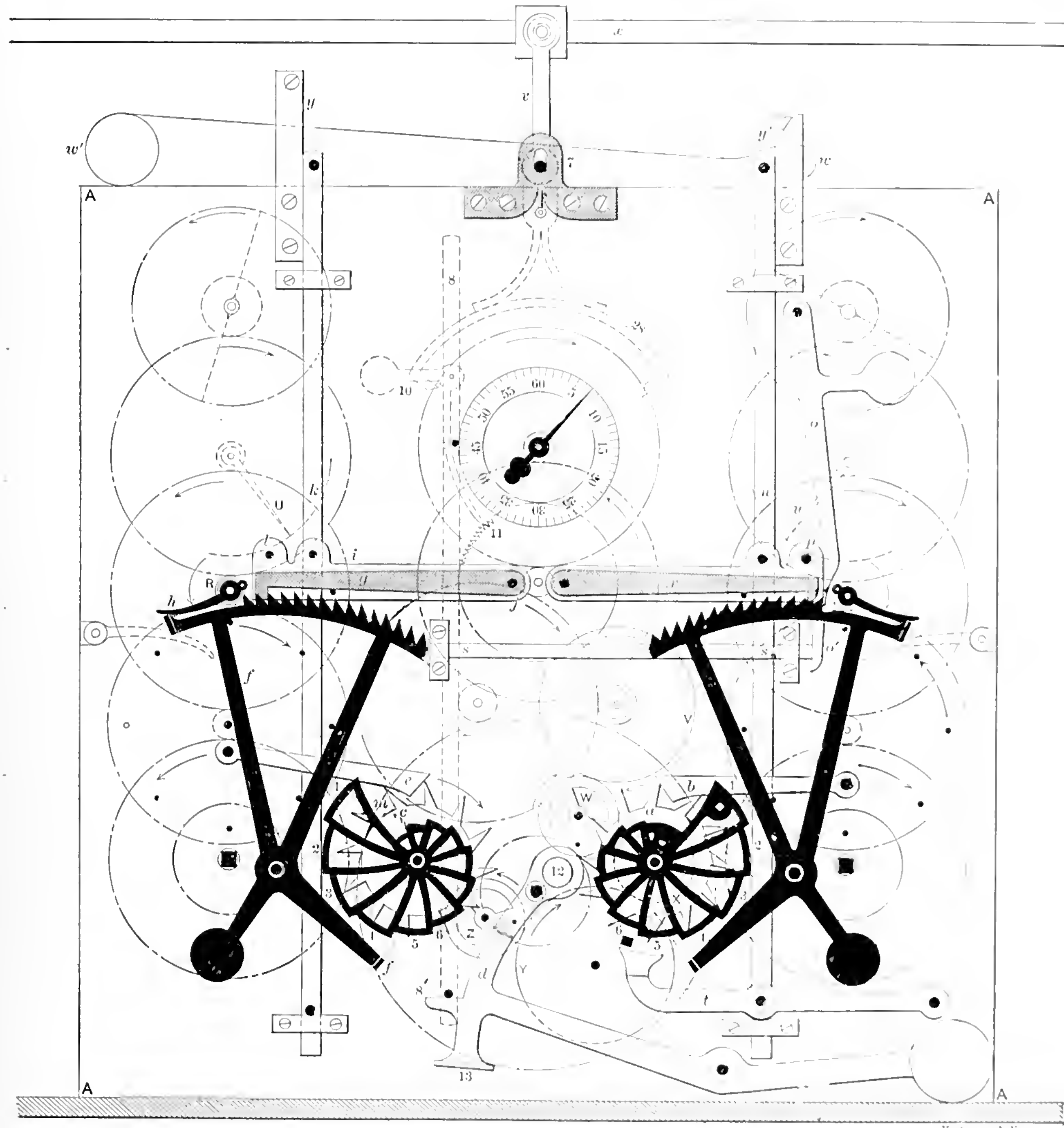


Fig. 3. Showing Snails, Wipers and Racks in Full Black

J are all fast on the axle N, so that the weight M is lifted with the hammer and in its descent gives force to the hammer K. Under the weight M will be seen a helical spring forming a cushion to prevent the pounding of the weight at each blow. The stem of weight M is guided through a hole in one of the pillars B as shown. The stem of the hammer O is spring steel and banks against a pin in the adjustable bell crank P, so that it may be set for the most effective blow of the hammer. Note that the hammer does not touch the bell when at rest. As wheel I rotates, as per arrow, a blow will be struck on the hour bell as each of the eight pins lifts and passes the hammer tail J. The hour bell is supported on a part. If these two trains were wound up they would strike continuously till run down, but their regulation to match the time will be shown in the next figure. Wheels drawn in dash and dot lines, V, W, X, Y, Z, are all outside the framework, V being fast on the axle D, prolonged through the frame, and rotating in ten minutes as described above. V drives W, which is half its size and therefore is the five-minute wheel, mounted on a stud. This five-minute wheel W is important, being the starting point for all calculations, relating to the repeating or striking mechanism.

In Fig. 3 we have the same framework, A, but shown as a plain plate to avoid complication. The 12-tooth star wheel a,

the 32-tooth gear wheel X, and the 12-stepped snail in full black, are fastened together and rotate on the stud as one piece. As the five-minute wheel W has a crank pin, plainly shown, it will move star wheel a one tooth each five minutes, or one turn in an hour. The 32-tooth gear X is therefore a one-hour wheel. Wheel X drives another 32-tooth wheel Z through the intermediate Y, usually called an idler. Now we have a one-hour wheel Z driving the star wheel c, one tooth each hour, or one step of the left-hand snail per hour. The piece in full black, $f f'$, is called the rack. The wiper h is now set or stopped by the rack, which is bent up at a right angle just under h, the rack itself being held in its present position by the hook g. The lifting piece i and the hook g are centered on a stud j common to both. Hook g is lying on a banking pin or stop riveted solid in i, so that if we lift vertical bar k we lift i and g also, and the rack being free will fall outward to the left because of its counterweight, till its tail f' strikes the step of the snail marked 5, its path being shown by dotted lines. The proportions are such that just five teeth of the rack have fallen to the left from under the hook g, and as the wiper h is now free we might expect the clock to strike, but it has only prepared to strike—"given warning"—for in lifting the hook g out of the rack we brought the stud l, which projects inward, into the path of the arm U, and the clock is held till we drop k, when everything is free and the striking goes on. On the hub end of the wiper h will be seen a little crankpin which at each turn of the axle R moves one tooth of the rack under the hook g, acting as a one-tooth pinion. Now as five teeth of the rack fell over, on the fifth turn of wiper h it arrives just where shown in the drawing and the striking is stopped at five strokes, namely, 5 o'clock. The tail of the rack at f' is bent up at a right angle just as it is under h. It is easy to see that as often as K is lifted the clock will repeat 5 o'clock, but the little crankpin of the one-hour wheel Z will come around and at 6 o'clock register the next step of the snail, which would allow six teeth of the rack to fall past. The snail is numbered only up to 6 o'clock, and should be continued to 12, the lowest step, but this is left out to avoid confusion in the drawing. The position of this hour snail and its star wheel c is maintained by the piece e which lies between two teeth by its weight as shown. As hour wheel Z rotates, as per arrow, its crankpin will engage a tooth of the star wheel, and as it moves, the tooth just above c will lift the piece e till it reaches the lower corner, at which point e will descend by its weight, driving star wheel c forward and landing in space m when step 6 will come opposite the tail f' and the clock is in position to strike 6. Let it be carefully noted that while the jumper e is being lifted, the clock will still repeat 5 o'clock, but that during its fall or jump it drives the star wheel c ahead and it is this motion which brings the 6 o'clock step under the tail f'. That is, the change to the next hour takes place in the fraction of a second in all cases. This striking of the last hour and the fact that the clock will not anticipate the coming hour by even one second must be kept in mind to understand the five-minute mechanism now to be explained.

We are now ready to consider the right or five-minute part of the movement. All that has been said about the hour side is equally applicable to the five-minute side, and to make this easier the drawing is made to show the position of five blows on the right side, too. It therefore follows that if lifting bar n is pulled up, the rack will fall past five teeth preparatory to striking five blows. But on lifting n the hook $o\,o'$ will fall in under the pin p and hold this side up, locking it so that n will not drop and the hook r will remain up, and pin p will stop arm u and hold the clock from striking. A cross slide $s\,s'$ touches the lower end of hook at o', the left end touching the hour rack. Now let us lift bars k and n together and let go, then k will fall and the hour will be struck, but n will be locked till the last blow of the hour brings the rack against cross slide at s', thus pushing out the hook $o\,o'$ and discharging or letting off the five-minute side, which in the position of the right-hand snail will strike five blows, giving 5.25. The five-minute wheel W and its crankpin will register star wheel a and five-minute snail on the first second of each five minutes, the jumper b acting just as e does for the hour side on the left. On the twelfth registration of wheel a and its snail the crankpin of one-hour wheel Z has come around, and on the even hour both snails register together, b and e jumping as nearly together as the eye can detect. But there is a slight difference, in fact, for b is adjusted to commence falling a very little ahead, to make sure that the hour could not register first, though practically they are simultaneous. According to the description so far, when the clock registers for the hour it would also register for twelve times five minutes, which would be a confusion and an absurdity, since only the hour ought to be struck till five minutes past has been reached. In other words, when the five-minute snail comes to that part of its motion which would strike twelve it must be prevented from doing so, as only the hour strike is wanted at that time. By looking at the highest step of the snail, marked 1, a square stud will be seen. This stud on the registration of the hour comes into the position shown by a solid black square near the figure 6, and gets into the range of the lever t which is connected to lifting bar n as shown, and prevents n, and therefore hook r, from being lifted, so the five-minute side is silent and only the hour is struck. At five minutes past, this stud has jumped to the position shown by the open square just to the right of the

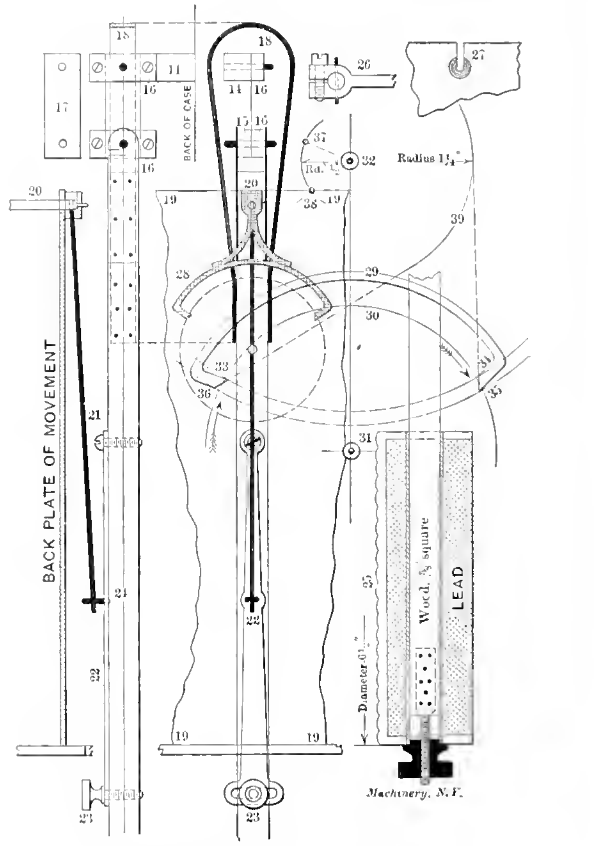


Fig. 4. Details of Pendulum, Support, etc.

figure 5, out of the way of lever t, and the clock is ready to repeat the hour and five minutes past. This repeating mechanism must be mounted delicately, and therefore a vigorous tug on the cord which lifts n would do harm when lever t comes against the stud on the snail. Provision for a little rough handling of the cord is made thus: The lifting bars k n are pulled up by lever $w\,w'$ through the link v connected to a crank on the shaft x which runs across the head of the clock and has an arm outside for attaching the cord. This lever $w\,w'$ is overbalanced a little at end w' as shown; end w therefore lifts first up against the stop y', then the pin in lower end of link v comes up against the upper end of the slot in the bracket 7, so that lever $w\,w'$ lifts the same at both ends, bringing up k and n alike. Now suppose the stud is in position as shown near 6, then end of lever at w is held down by lever t, but the pin in link v strikes the top of slot of 7 just the same, the lever at y rising twice as far, which does no harm. In both cases the important stop is the bracket 7 which is made extra strong, and a little consideration will show that no matter how hard you pull the cord the extra force is taken by 7, and the square stud in the snail can never receive more pressure than the slight overbalancing at

the end of the lever w'. A vertical bar inside the movement is shown at 8 8'. This bar carries a click 10 which in its present position just clears a fine-tooth ratchet wheel, 11, on the axle of the second wheel. This bar and its click or ratchet are held up by a weighted lever d catching a stud at 8'. It will be seen that this lever covers the winding square of the time train, but by pushing down its end, turned out like a step at 13, the winding key can be introduced, as opening 12 comes opposite the winding square. But while the key is in use bar 8 8' has lost its support under stud 8' and its ratchet 10 catches the wheel 11 and drives the clock during the time of winding. On withdrawing the key the parts assume the position shown on the drawing. Ratchet 10 does not touch wheel 11 except when in use during winding, so there is no drag or disturbance of the clock. Springs have been almost left out of this clock, as experiments I have made have shown that gravity is far superior, especially where a uniform action is necessary, as in the blow of the hammer, the jumpers e b, the sustaining power 8 8', and the rack f f'. The wheels W and Z have heavy sides where the crankpins are placed. These wheels operate on the star wheels for about a minute and at the hour they operate together, so the time train must be overweighted enough to do this work and this is always objectionable. An attempt is made here to reduce that evil by making the heavy side of W about equal to half the force, consequently half the force comes on the wheel W

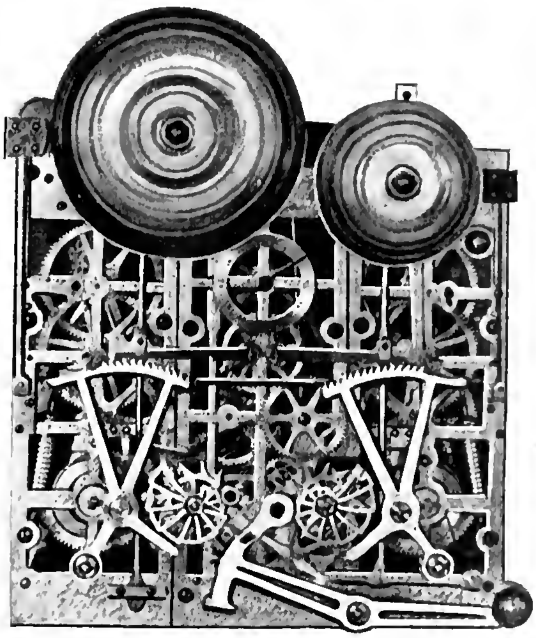


Fig. 5. Front View of Works out of Case.

twice in five minutes. If the wheel W were balanced, then the whole force necessary to move star wheel a would come on once in five minutes. The wheel Z is treated in the same way, but since during the last minute of each hour both W and Z act together, an attempt has also been made to lessen that difficulty, the right-hand snail having a heavy side so placed that it assists at this critical moment, and thus divides this pull into half-hourly parts. The left-hand, or hour snail is, for evident reasons, balanced.

In clock trains where the wheels drive pinions it is always desirable to do the driving after passing the line of centers, and high-class clock wheels are always cut so that the wheels drive by their faces acting on the flanks of the pinions. As this clock is cut with involute cutters, as used for general gear cutting, a similar result is produced as follows: Wheels are sized as usual, but cut five per cent deeper than standard, giving a rather thinner tooth. The pinions are sized one-half diametral pitch smaller than standard. That is, to their pitch diameter is added only 1½ diametral pitch, and they are cut standard depth. Thus in both wheels and pinions the teeth are a little thinner than usual and give the necessary freedom for clockwork, as perfectly fitting gears would be easily stopped by dust or sticky oil. On the other hand, this freedom or back-lash does no harm, since clock gears drive slowly and steadily in one direction. Finally this undersizing of the pinions, which is really making them of a smaller pitch than the wheels, gives an easy entrance and brings the principal pressure of driving during delivery after passing the line centers.

Fig. 4 gives some details. 14 is a heavy stud, solid in a plate going across the back of the case. In this stud and also in piece 15, pins ⅛ inch in diameter, shown in black, are driven fast. The clamping pieces, 16, are alike and clamp the spring at both ends. The spring is ¾ inch wide and .008 inch thick and is 1 inch free between clamps. Clamps 16 are an easy fit for the pins. The spring is of the simplest form and is shown at 17. The pendulum rod is ⅝ inch square wood and has steel cheek pieces riveted on, forming a double hook as shown. A safety loop 18 is also riveted to the pendulum rod, so that should the spring break at any time in future this loop would drop on stud 14 and the pendulum would be saved from falling to the bottom of the case. A portion of the clock frame in relative position is shown at 19, so it is easy to see that the pendulum is suspended very much higher above the pallet staff, 20, than is usual. The crutch, 21, is a straight spring wire and passes freely between two studs fast in the sector, 22. The crutch is adjusted as near the center of the movement as possible, but after the clock is set up plumb a final adjustment to get a uniform beat is easily made by the thumb nut 23. As 24 is the center line of suspension for the pendulum, it is seen that the crutch acts on the two studs ⅝ inch in front of said center line, but no twisting action can be detected owing, no doubt, to the wide spring and the heavy pendulum. The action is so satisfactory that this method is preferable to the usual plan of bending out the lower end of the crutch, 21, so as to act in the center line, 24. So long as the pendulum does not show any twist in its swing it may be assumed that the direct action of the crutch straight from the axle or staff 20 is all gain. The bob of the pendulum, 25, is 6½ inches diameter, 2 inches thick and weighs 26 pounds. It is a brass dish with a ⅝ inch square tube put through it and then filled with lead. The face is covered with concentric beads of a flat curve as shown in section, so that it blazes with reflected light at almost any angle of view, and has a very live appearance. The bottom screw and nut are plain enough at sight. At 26 is shown an enlarged view of a clamp hub, freely used in the clock, which can be adjusted and tested easily, and finally pinned, making it practically solid metal, and yet it can be taken off easier than a plain pinned hub. The one on the anchor at 20 is not pinned as it is subject to future adjustment in repairing the clock.

The wire cords of the clock are knotted on the free end and dropped into the recess shown enlarged at 27, so when they are adjusted to length and their ends knotted they need not be disturbed while they last. This simple moving of the knotted ends of the cords and the hooking up of the vertical shaft in the head of the clock enables the movement to be lifted out of the case much easier than in the usual clock of commerce. In the three figures the anchor, 28, is drawn for convenience as a dead beat, but it has a little recoil and is drawn to double size at 29 for the benefit of any one who might wish to lay out an escapement of this kind. Portion of circle 30 represents a 3-inch scape wheel, 31 being its shaft. 32 is the pallet staff or shaft of the anchor 29, and these are 3 inches distance of centers. The sector of a circle, 33-34, cuts scape wheel 30 in two points 120 degrees apart, or one-third of the scape wheel's circumference. Circle 35-36 is ⅛ inch greater in radius than this. Between these circles lie the impulse faces of the pallets, their angles being determined by the tangents to the circle 39 as plainly shown. The left-hand pallet is drawn from the center 37, and the right-hand one from the center 38. The result is that acting surfaces 36 and 34 give a little recoil to the scape wheel. If the pallets were laid out from center 32 and therefore lying between circles 33-34 and 35-36 the escapement would be a dead beat, but experiments have shown that a construction of about the proportions shown, in which the left pallet leans inward and the right pallet leans outward, gives steadier timekeeping. This form, which gives a slight recoil, is sometimes called the half-dead escapement. Finally, it is well to remember that there is nothing imperative in these proportions, for makers differ about them; but the above proportions have been found very good for a brass scape wheel and steel pallets, as in this clock.

MORE NOTES ON BAND BRAKE DESIGN.

C. F. BLAKE.

In the issue of MACHINERY for January, 1901 the writer gave formulas and a convenient chart for the solution of the holding power and tensions in the brake band. The chart was also reproduced in one of the data sheets of March, 1903. The formulas and chart then given applied to flat-faced brake wheels only, and since the V-grooved brake wheel is often met with, we must find the increased holding power due to the wedging of the blocks into the V-groove.

Referring to Fig. 1, let $N =$ the normal pressure on a flat-faced wheel, $n =$ the normal pressure on one side of a V-grooved wheel, $2n =$ the total normal pressure on a V-grooved wheel.

Let $b\text{-}c = \frac{N}{2}$ for a flat wheel of diameter D, which is the mean diameter of the V-grooved wheel.

Then $b\text{-}d = n$, and $\sin.a = \frac{\frac{N}{2}}{n} = \frac{N}{2\,n}$

and

$$n = \frac{N}{2 \sin. a}.$$

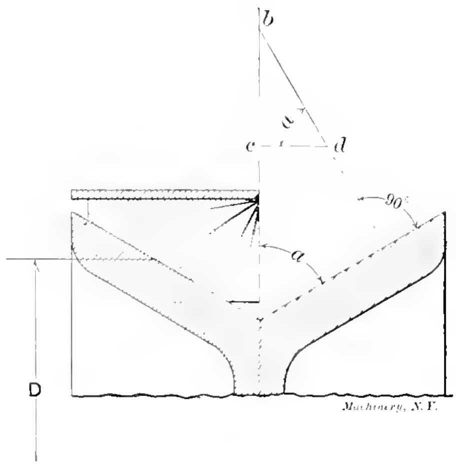


Fig. 1.

Since the pressure n is exerted on each side, we have

$$2n = \frac{N}{\sin. a}.$$

The tangential force P for a flat face $= N\,\mu$, and for a V-grooved face the tangential force $P_1 = 2n = \frac{N\,\mu}{\sin. a}$. Then

$$\frac{P_1}{P} = \frac{\frac{N\,\mu}{\sin. a}}{N\,\mu} = \frac{1}{\sin. a} = \text{cosec. a.}$$

and

$$P_1 = P \text{ cosec. a.}$$

The following table gives the values of the cosecants of various angles, for use in the above formula:

Angle a Degrees.	Cosec.	Angle a Degrees.	Cosec.	Angle a Degrees.	Cosec.
15	3.86	46	1.39	80	1.015
16	3.63	48	1.35	82	1.009
18	3.24	50	1.31	84	1.0055
20	2.92	52	1.27	86	1.0024
22	2.67	54	1.24	88	1.0006
24	2.46	56	1.21	90*	1.0000
26	2.28	58	1.18		
28	2.13	60	1.15		
30	2.00	62	1.13		
32	1.89	64	1.11		
34	1.79	66	1.09		
36	1.70	68	1.08		
38	1.62	70	1.06		
40	1.56	72	1.05		
42	1.49	74	1.04		
44	1.44	76	1.03		
45	1.41	78	1.02		

* Flat face.

Fig. 2 represents various forms of band brakes. At A the fixed end, T_2 is passed through the loose end, T_1, securing a large arc of contact. At B the fixed end is also passed through the loose end, and is fastened to the shaft or pin of the operating lever. C is the so-called differential brake. The arms, e and c are made in inverse proportion to T_1 and T_2. Thus we have,

$$\frac{T_1}{T_2} = \frac{c}{e},\ T_1\,e = T_2\,c$$

And since $T_2 = k\ T_1$, we have $e = kc$.

Substituting these values we have,

$$T_1\,kc = kT_1\,c.$$

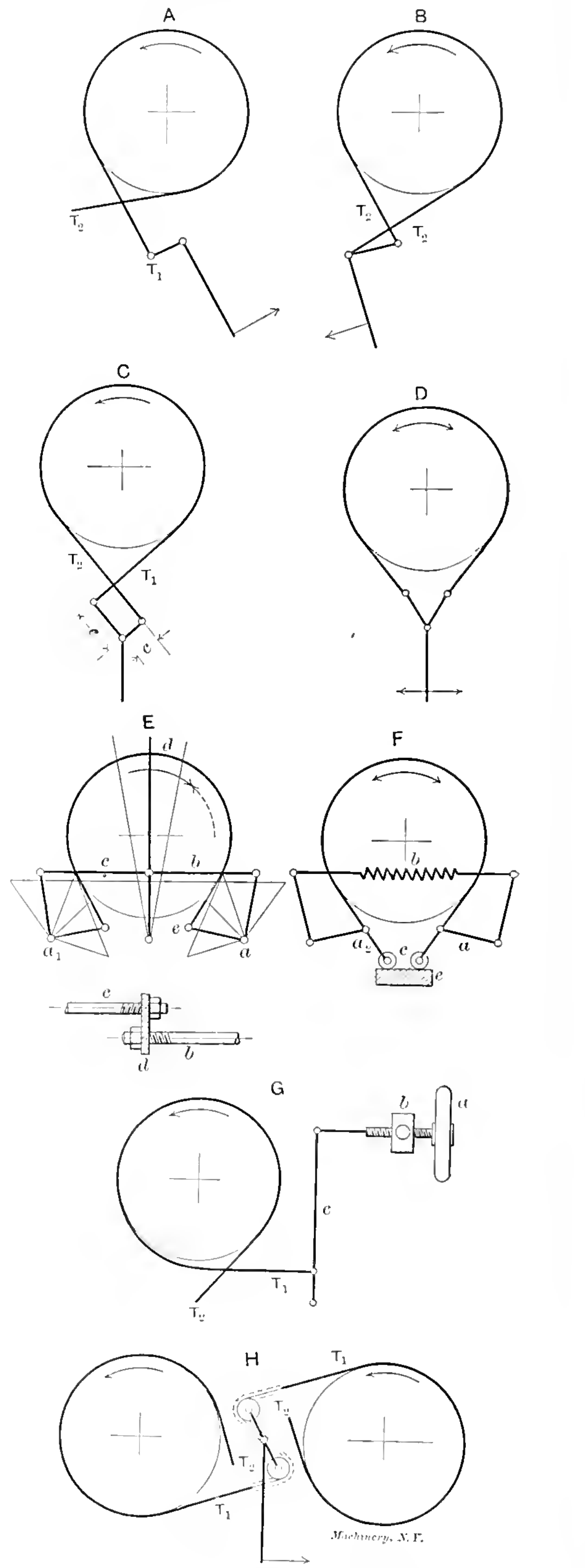


Fig. 2. Showing Various Forms of Band Brakes.

Thus it requires very little force to apply the brake, making a brake, indeed, too sensitive for frequent use on cranes.

D is a form of brake that is used where the brake must be applied with the brake wheel running in either direction. This form is only applicable to light loads, since there is no fixed

end and the brake cannot be made on the differential principle for each direction of rotation.

E represents a form of brake to be used with a wheel rotating in either direction, and having a fixed end for each direction of rotation. The ends of the strap are fixed to bell cranks, a_1 and a, which bell cranks are attached to the operating lever d, by links, c and b. Let the wheel be supposed to be turning in the direction of the dotted arrow when the brake is to be applied. Moving the lever d toward the dotted position we pull on the link, c, while sliding freely on the link, b, and thus we pull bell crank, a_1, toward the dotted position while bell crank a will move toward the dotted position under the influence of the friction of the band on the revolving wheel. The position of the bell cranks is made such that the end e of crank a will come in contact with the rim of the wheel upon very slight movement of the crank, thus forming a fixed end for the strap, the arm c-a forming a strut between the rim of the wheel and the point a. The reverse of this action will take place when the wheel is revolving in the direction of the full-line arrow.

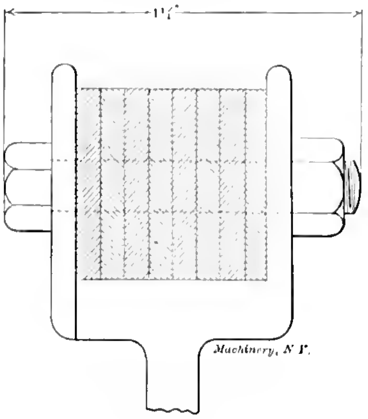


Fig. 3. Brake Wheel with Friction Member in the Wheel.

F is an application of the same mechanism to a solenoid brake for electric cranes. The tension upon the band is produced by a spring, b, and the brake is released by the lever e being raised against the rollers on the bell cranks by the solenoid.

G is a very powerful form of brake employed for heavy loads. It is operated by a handwheel on a screw turning in a pivoted nut, b. The screw and band are attached to a lever, as shown.

H is a form of brake applicable to two brake wheels, useful in confined spaces. The band is continuous, embracing both wheels, the central portion between the wheels being flexible, (conveniently of chain), passed over rollers on the arms of a bell crank. The operation is evident from the sketch, the rollers and chain forming an equalizing device to compensate for uneven wear of the bands upon the two wheels, or a difference in adjustment.

Fig. 3 shows an excellent form of wheel in which the friction member is in the wheel instead of being a lining for the band. The rim is made with a loose flange, and thin strips of wood, fiber, leather or paper, are clamped between the flanges. The encircling band may then be steel without a lining.

Example: A band brake is required to hold 136,160 inch-pounds torque; wheel to be V-grooved, 120 degrees, a = 60 degrees; holding power = 1.15 × holding power of flat band, mean radius of wheel being 18 inches.

Required torque flat band should hold $= \dfrac{136{,}160}{1.15} = 118{,}400$ inch-pounds.

$\dfrac{118400}{18} = 6577$ pounds tangential force necessary.

Arc of contact being 270 degrees, coefficient of friction = .3, $k = 4.11$.

$P = T_1\ (k - 1)$

$6577 = 3.11\ T_1$

$T_1 = 2115$ pounds pull necessary in loose end of band.

$T_2 = 2115 \times 4.11 = 8692$ pounds pull in fixed end of band.

$P = T_2 - T_1 = 8692 - 2115 = 6577$ pounds (check).

The Clam Shell Brake.

The type of brake known as the clam shell, Fig. 4, is often used in place of the band brake. The cast arms, H, are pivoted at A on the frame of the machine, and carry blocks K formed to grip the brake wheel. Links BE and CD connect the arms H to bell crank $DEFG$, pivoted to the frame at F.

From A draw lines through the center points of contact at a, a', on the rim of the wheel; also from A as center draw circle c-c-c, cutting these lines at B and C. At these points draw tangents BE and CD to the circle e-e. Draw circle n-n-n tangent to BE and CD. The radii of circles e-e and n-n are chosen to give the required leverage to the brake system, and we have

$$ca = \frac{P \times GF \times CA}{FD \times Aa}$$

and,

$$c'\,a' = \frac{P \times GF \times BA}{FE \times Aa'}$$

By the method of construction we have,

$$CA = BA,\ FD = FE, \text{ and } Aa = Aa',$$

therefore

$$ca = c'\,a'.$$

The force ca resolves into components ab and bc, and since from the theory of similar triangles we have angle cab = half the angle y,

$$ab = ca \times \cos.\ \frac{y}{2}$$

also,

$$a'\,b' = c'\,a' \times \cos.\ \frac{y}{2} = ca \times \cos.\ \frac{y}{2}$$

The forces ab and $a'\,b'$ multiplied by the coefficient of friction f, form a couple tending to retard the rotation of the wheel, and we have for the torque absorbed by the brake,

$$ab \times f \times aa' = \left(ca \times \cos.\ \frac{y}{2}\right)\ (f \times aa')\ \ldots\ldots\ldots (1)$$

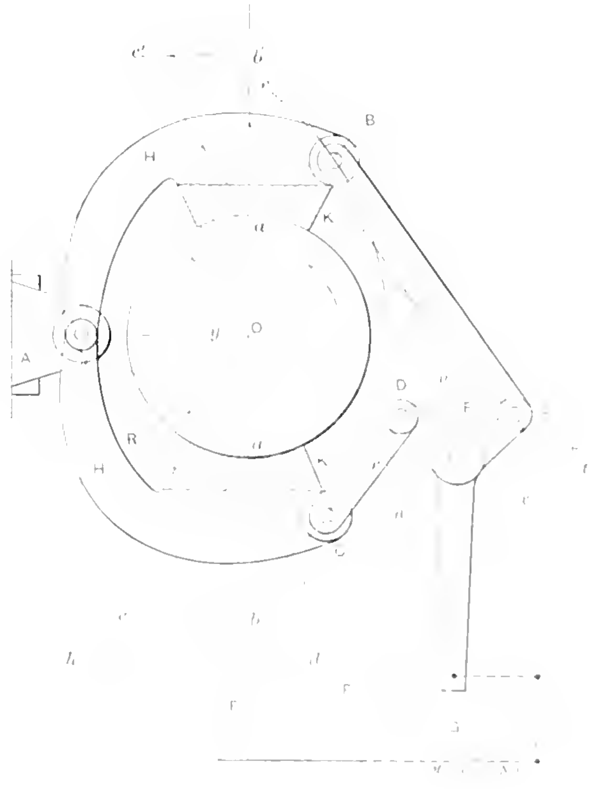


Fig. 4. The Clam Shell Brake.

The forces bc and $b'\,c'$ are transferred to A; also we have on A a force $2ab \times f$, the direction of which is determined by the direction of rotation of the brake wheel.

Supposing the wheel to be turning in the direction of the full-line arrow in the sketch, we should then have upon A the two forces $Ah = 2ab \times f$, and $hd = cb + c'\,b' = 2cb$, and resolving these we find R, $= Ad$, as the resultant pressure on A.

Example: Suppose the system of leverage such that

$$ca = c'a' = 1000 \text{ pounds},$$

Let y = 66 degrees, then $\cos. \frac{y}{2} = 0.838$,

$f = 0.3$, diameter of the brake wheel = 20 inches.

From (1),

$$T = (1000 \times 0.838)\ (0.3 \times 20) = 5028 \text{ inch-pounds.}$$

The figure shows no device for adjustment for wear. This is accomplished in many ways, but should always be of the nature of an equalizing device. This bars out putting adjustment into links *BE* and *CD*, as is sometimes done, it being impossible to adjust the two blocks evenly by this method.

The point *F* may be made a floating center, which then automatically adjusts evenly for wear. This is often done, replacing the double bell crank *DEFG* by a single lever, *rst*; although it is not good practice, since the load at r is $p = \frac{P\ (t\,s)}{r\,s}$, and at s is $P + p$, resulting in an uneven pressure on the blocks, the upper receiving the greater pressure by an amount $P + 2\ W$, if W is that portion of the weight of the arms and links supported at a'.

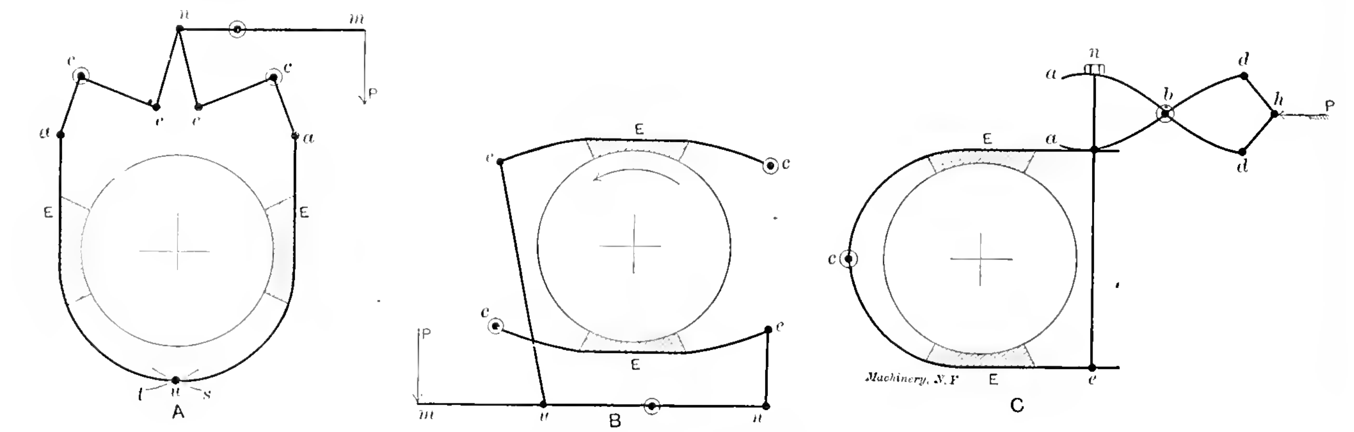


Fig. 5. Several Types of Brake.

A better method of making *F* a floating point is to keep bell-crank *DEFG* and attach thereto another bell-crank by a link, as shown in dotted lines. Where there is room to place this construction beneath the brake as shown, or to put a bent lever, *DE*, upon a shaft, *F*, and off to one side to place a lever, *FG*, attached to the link and bell-crank, this makes an excellent arrangement and equalizes all pressures upon the blocks except that due to the weight of the parts.

The point *A* may be placed below the wheel, making the axis $a\,a'$ horizontal, with *F* a floating point, the arms *H* falling apart by gravity when released; and when the arms are not heavy enough to do this without having one of them bear against the wheel while the other is free, light springs may be attached to points *B* and *C*, to keep them apart when released.

The arms are sometimes extended so that points *B* and *C* may be connected by a spring which sets the brake, the release being made by levers separating the arms when applied. The wheels of these brakes may be made V-shaped, as explained for band brakes, and the same formula and table for the increased braking power applies. The blocks *K* are often made to embrace a larger portion of the wheel than shown, sometimes nearly 180 degrees. Types of this brake are often seen on electric cranes in connection with solenoid operating devices.

Fig. 5 shows several types of this brake, the fixed points being shown by a dot within a circle and the floating points by a heavy dot. *A* is a brake useful when there is no convenient way of pivoting the arms to the frame at u. The bell-cranks $a\,c\,e$ and lever $m\,n$ are pivoted as shown, but the point u is fixed in space only by its geometrical relations to points a. Since the arcs s and t, struck from the points a, cross at u, it is evident that the point u becomes fixed in relation to points c where the system is connected to the frame, and thus u is the fulcrum of the arms *E*, although not the point which receives the thrust of the brake arms, this being taken at points c.

At *B* is shown a good type of brake, the feature being that both arms act as tension members in transferring the braking force to the fixed points c.

At *C* is a brake set with a toggle composed of two bent levers, $a\ b\ d$, fixed at d; the points a, being forced apart, press down on the upper arm *E*, and pull up on the lower arm *E* by means of the rod $e\,n$. The toggle forms an equalizing device, so that only one adjustment is necessary.

* * *

IMPULSE AND REACTION TURBINES.

A question frequently asked by those studying the steam turbine is "What is the distinction between the impulse and the reaction turbine?" Both water and steam turbines are grouped into two general classes known as impulse and reaction turbines, and to make clear the distinction between the two types, it will be necessary first to give an explanation of the terms "impulse" and "reaction."

Meaning of Impulse and Reaction.

A reaction is a force acting in a backward direction. According to older writers in mechanics, an impulse is a force acting in a forward direction. Strictly speaking, this is not correct. An impulse is not a force in the sense of being a push or a pull, but is a term used to express the same meaning as momentum, when the force acts for a very short space of time, as when one body gives another a sharp blow. When we speak of an impulse turbine, the older meaning of the term is usually implied to distinguish it from a reaction turbine; but it would be more consistent to speak of the two types as action and reaction turbines, as in fact is sometimes done. Even these terms, however, would be somewhat mis-

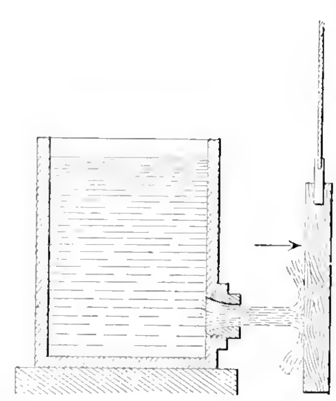


Fig. 1.

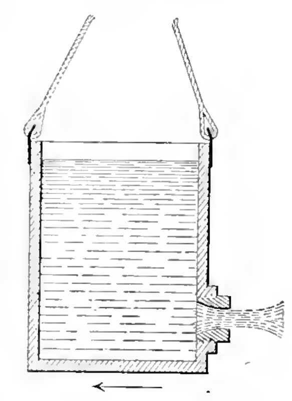


Fig. 2.

leading, because all practical turbines operate both by the action and reaction of the working fluid, and it would be better to designate the two classes in some other way.

In Fig. 1 is a tank from which water issues through a nozzle and impinges against a flat surface capable of moving horizontally—in this case the face of a plank suspended so that it is free to swing. When the water strikes the plank the latter will swing to the right under the pressure due to the impulse of the jet. As the jet leaves the nozzle, however, it exerts a reaction or backward kick against the tank, which is equal and opposite to the force due to the impulse of the jet. This

may be illustrated by suspending the tank, as in Fig. 2, so that it is free to swing, when it will move to the left, owing to the reaction of the jet.

The explanation of the reaction is that there is no pressure on that part of the tank where the nozzle is situated and the unbalanced pressure on that part directly opposite to the nozzle will therefore tend to move the tank in a direction opposite to that in which the water is escaping. The faster the water escapes, the greater the pressure required in the tank to give the water its velocity; and hence the greater the unbalanced pressure which we call the reaction. It is on this principle that a gun "kicks." If a blank cartridge is fired, the pressure due to the burning powder acts one way against the bottom of the barrel and the other way against the air and the former pressure produces the reaction. If the gun is loaded with a bullet it requires a higher pressure in the barrel to start the bullet on its course, and the reaction or kick is greater. Assuming the bullet to absorb all the energy of the charge, the momentum of the bullet would be equal to

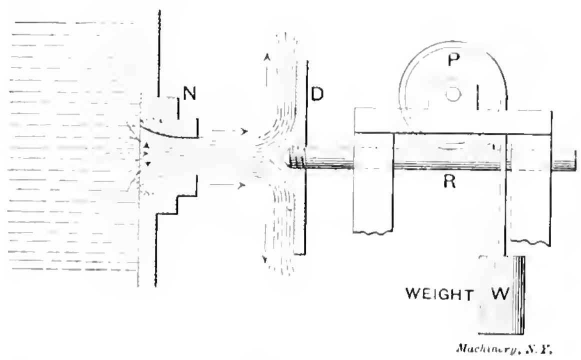


Fig. 3.

the momentum of the gun at the time of firing; but the gun, being many times heavier, would fortunately have much less velocity.

Impulse and Reaction upon Curved Vanes.

In Fig. 1 the velocity of the jet is suddenly checked when it strikes the plank, and there is more or less commotion of the particles of the fluid, causing loss of energy. This is always the case when there is impact of particles against a surface and is to be avoided by using a curved surface so placed as to change the direction of flow gradually without shock or jar. Such an arrangement is shown in Fig. 3, where a nozzle N is discharging against a plate D attached to the rod R. The rod is supported by guides and together with the plate can move longitudinally. The pressure of the jet against the plate is balanced by the weight W supported by a cord passing around the pulley P and attached to the rod R. The plate D is so shaped at the center as to gradually guide

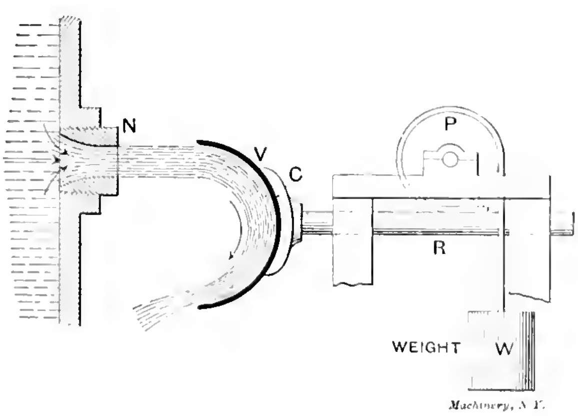


Fig. 4

the particles of water through an angle of 90 degrees, thus avoiding the impact present in Fig. 1, and the particles leave the plate in a direction parallel with its face. It is evident that the pressure against the plate is due solely to the impulse of the jet and that the reaction of the water in leaving the plate has no tendency to move the plate longitudinally.

In Fig. 4, however, the case is different. Here the water strikes a curved surface and is turned back upon itself through an angle of 180 degrees. This surface is therefore acted upon by two forces, both tending to move it to the right. The first is that due to the impulse of the jet, just as in Fig. 3, which acts until the central point C of the curved surface is reached; and the second is the reaction of the jet, which begins where the jet starts to flow backward and continues up to the edge where it discharges. Both of these forces would be equal if there were no frictional or other losses, and it would require a weight, W, just twice as heavy as the weight in the first example to balance the end thrust.

Impulse Turbines.

All turbines known as impulse steam turbines, like the De Laval, for instance, operate on the principle of Fig. 4 The

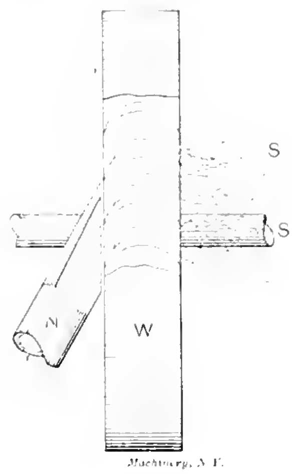


Fig. 5.

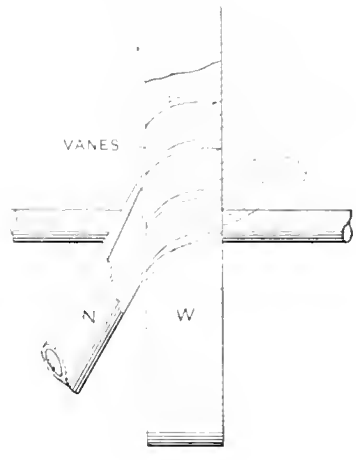


Fig. 6

turbine wheel has curved vanes, as in Fig. 5, against which the jet of steam impinges. The expansion of the steam is completed within the nozzle, and there is no expansion in passing through the wheel passages. The pressure between the vanes is the same as the pressure within the casing in which the wheel runs, and the steam flows freely through the wheel passages in virtue of the momentum given it in the nozzle. The wheel is driven ahead, first by the pressure due to the impulse of the steam and then, after the vanes have reversed the direction of flow, by the reaction of the steam.

In Fig. 5 N is the nozzle, which may or may not be a diverging nozzle, according to the pressure against which it is

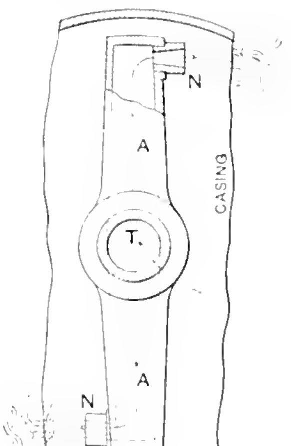


Fig. 7

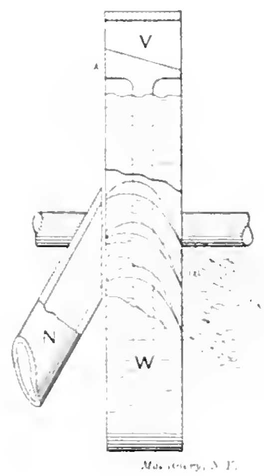


Fig. 8

discharging, and W is the wheel. With the vanes constructed as shown, there would be spaces S S not filled by the steam, since the area of the passages at these points is greater than at the entrance and exit. Some manufacturers, however, make the blades thicker at the center than near the edges, to maintain a constant area and so avoid possible eddy currents. Although a so-called impulse wheel, it will be evident that this wheel acts both by impulse and reaction. The chief characteristic of this type is that the expansion occurs wholly in the nozzle or guide passages, as the case may be, and the steam flows freely through the wheel in virtue of its momentum, without expanding or acquiring additional velocity in the wheel passages.

What would strictly be an impulse wheel is shown in Fig. 6, where the vanes are so curved that when the wheel is held stationary the steam leaves them in a direction parallel with the shaft. The wheel is therefore propelled solely by the pressure against the vanes due to the impulse of the steam, and would be inefficient because the steam would have a high residual velocity when it left the wheel. Such a wheel is on the principle of the stationary vane in Fig. 3, against which the water exerted only half the pressure that it did when the force of reaction was taken advantage of.

Reaction Turbines.

In Fig. 7 is the simplest type of reaction wheel. Here the steam enters the trunnion *T*, flowing radially outward through the two hollow arms *A A*, until it discharges through the nozzles *N N*. The arms therefore rotate in a direction opposite to that in which the steam escapes, and are driven entirely by the reaction of the steam. The chief difficulty of this type of wheel is the excessively high speed of rotation. Supposing the wheel to be perfectly free to move, its momentum would be equal to the momentum of the escaping steam. The velocity of the arms therefore would be less than the velocity of the steam only in so far as the mass of the arms was greater than that of the steam.

In Fig. 8 is shown a more practicable form of reaction wheel. Here there is first the impact of the steam against the buckets, but the expansion in the nozzle is only partial and the steam expands still more and acquires additional velocity in flowing through the wheel, provision being made for this, if necessary, by having the passages diverge in the direction of the flow, as at *V*. The steam therefore reacts upon the wheel when it leaves the vanes as a result of the energy acquired in the wheel itself, and this feature gives it the name of a reaction wheel. It will be seen that the wheel acts both by the impulse and the reaction of the steam just as in the case of the impulse wheel. The distinction between the two, however, is that in the impulse wheel the expansion of the steam is complete within the nozzle and in the reaction wheel it is not completed until after it enters the wheel passage. If it were possible to attach a steam gage to one of the spaces between two wheel vanes, it would show a pressure equal to the pressure of the medium in which the wheel was turning in the case of the impulse turbine, and a pressure higher than that of the surrounding medium in the case of the reaction turbine.

* * *

VARIABLE SPEED MOTORS.—10.

THE H. WARD LEONARD CONTROLLERS.

WM. BAXTER, JR.

The H. Ward Leonard Company make a number of designs of controllers for variable-speed motors. Some of these are arranged to vary the velocity by means of armature resistance, and are not designed for use in connection with machine tools. The controllers intended for this latter service are arranged to vary the speed by means of field regulation.

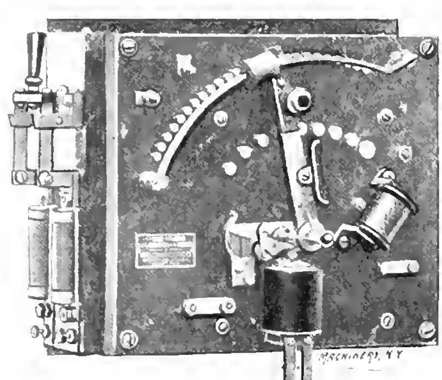


Fig. 1. Standard Type of Controller.

The standard controller of this type is shown in Fig. 1, and as will be seen is very simple, being in fact a modification of the standard Ward Leonard automatic motor starter, the modification being such as will enable it to vary the resistance included in the motor field circuit.

As will be seen in Fig. 1 the controller is provided with a side panel on which are mounted a two-pole main switch to connect the motor circuit with the main line, and a pair of safety fuses to protect the motor from excessive currents. The controller proper is provided with a circuit breaker, seen at the bottom of the slate front, so that the motor has double protection. The circuit breaker will respond to instantaneous rushes of current strong enough to energize the magnet to the active point, while the fuses will respond to weaker currents of greater duration. By adjusting these two protective devices properly, the safety of the motor is fully insured. The circuit breaker is adjusted so as to respond to a current strength considerably greater than that required to melt the fuses and will act whenever there is a sudden rush of current which, on account of its short duration, would not heat the fuses. The latter will come into action with a considerably weaker current than is required to actuate the circuit breaker, provided it continues for any length of time.

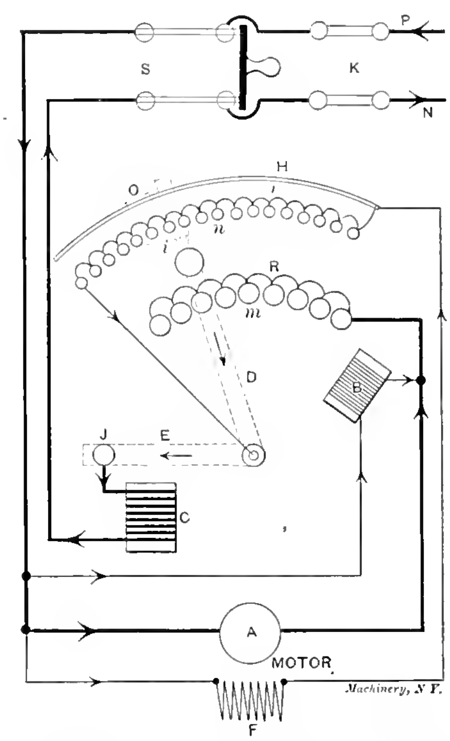


Fig. 2. Diagram of Controller, showing Circuit Connections.

The circuit breaker protects the motor from sudden rushes of current, not only when it is running but also in the act of starting. Thus, if an attempt is made to start the motor when it is overloaded, or if the operator advances the starting lever too rapidly, so as to cut out the starting resistance faster than the armature c. e. m. f. builds up, the circuit breaker will be actuated and thereby compel the operator to make a new start. If after two or three attempts carefully made, the circuit breaker still persists in acting, it is an indication that the load on the motor is more than it should carry.

The retaining magnet located at the right side of the controller will hold the operating switch in the running position, that is, with all the armature resistance cut out, so long as current flows through the motor. To make this action sure, with a motor in which the speed is varied by introducing resistance in the field circuit, it is necessary that the coil of the retaining magnet be connected in a circuit that is entirely independent of the field; if not, when the field current is weakened to obtain the highest motor velocities, the strength of the retaining magnet may not be sufficient to hold the operating lever in the running position. The arc of small contacts located at the top of the slate front, is for the purpose of varying the resistance in the motor field circuit. The regulating resistance is connected with these contacts, and the metallic curve above them is connected with one end of the resistance. The sliding contact on this curve, when in the extreme left position, short-circuits all the field regulating

resistance, and when in the extreme right position, cuts it all into the circuit.

In starting the motor the operating lever is advanced in the same way as in the ordinary motor starter, until it rests against the retaining magnet and is held by the latter in that position. This gives the slowest motor velocity. If it is desired to increase the speed, the contacting block that slides on the upper curve is advanced until the required velocity is attained. When the motor is stopped, the operating lever in swinging back to the stop position carries the contacting block with it; so that every time the motor is stopped all the resistance is cut out of the field circuit, and hence, there is no danger of starting the motor with a weakened field

Circuit Connections of the Ward Leonard Variable-speed Controller.

The circuit connections of this controller can be readily understood from the wiring diagram, Fig. 2. The main starting two-pole switch is shown at *S* and the fuses at *K*. The controller occupies the center of the diagram and the motor is shown at the bottom. Tracing the current from the positive line, *P*, through the motor armature, *A*, it reaches the right

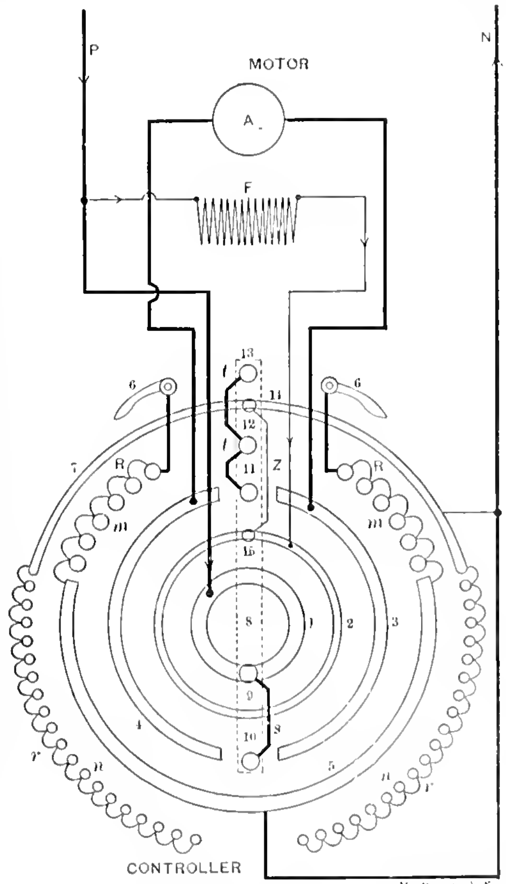


Fig. 4. Circuit Connections of Reversible Type Controller.

side, *m*, contact of the controller, and passing through the starting resistance, *R*, reaches the operating lever, *D*. Thence through the circuit-breaker lever, *E*, to contact, *J*, and through the coil of the circuit-breaker magnet, *C*, to the negative side of the line, *N*. It will be noticed that the field circuit starts from line, *P*, and after passing through the shunt field coil, *F*, of the motor, goes to the curved contact, *H*, which is connected with the right-side end of the field regulating resistance, *r*. From the left-side end of this resistance the circuit passes to the stud around which *D* and *E* swing, thus completing the field circuit. The retaining magnet, *B*, has its coil connected in an independent circuit that is connected in parallel with the armature, as is clearly shown.

In starting the motor, lever *D* is advanced slowly to the extreme right side position, where it is held by magnet, *B*. To increase the motor velocity above the normal, contacting block, *G*, is advanced toward the right until the desired speed is reached. When the motor is stopped, the extension of lever *D* carries *G* back with it to the starting position, and thus cuts out all the resistance in the field circuit. The extended end of *D* is insulated from the lower portion, as indicated by the shading at *i*.

The way in which this controller is mounted upon m... [illegible] tools is well shown in Fig. 3, in which it is attached to ... side of a Gould & Eberhardt shaper.

Reversible Controller for Variable-speed Motor.

The diagram, Fig. 4, gives the circuit connections of one style of Ward Leonard controller of the reversible type. The controller itself is shown in Fig. 5. The principal feature about this controller is that means are provided whereby the

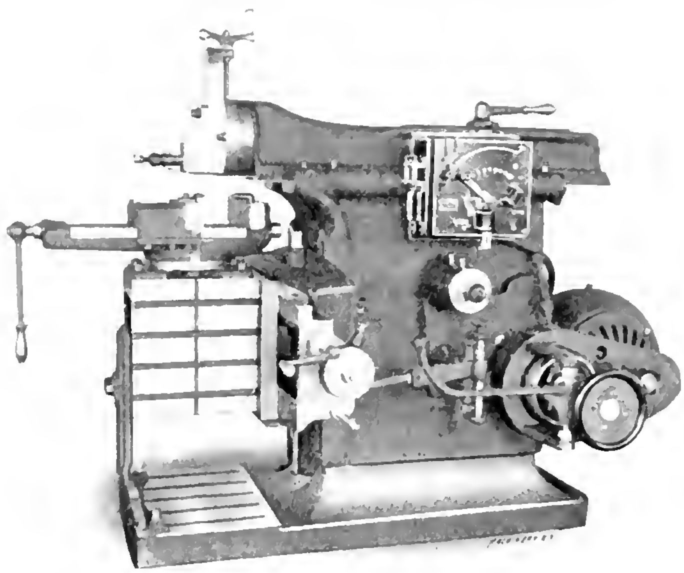


Fig. 3. Showing Controller mounted on a Gould & Eberhardt Shaper

circuit is made quickly when the motor is started and is broken quickly when it is stopped. The effect of this quick make-and-break is to prevent excessive burning of the contacts, either by making imperfect contacts in the act of starting, or by slowly-drawn-out arcs in the act of stopping. In addition the construction is such that the circuit is closed in starting and broken in stopping at isolated contacts that are massive and capable of withstanding severe sparking, and thus the smaller contacts are protected and are prevented from becoming roughened at the points of separation.

Fig. 6.

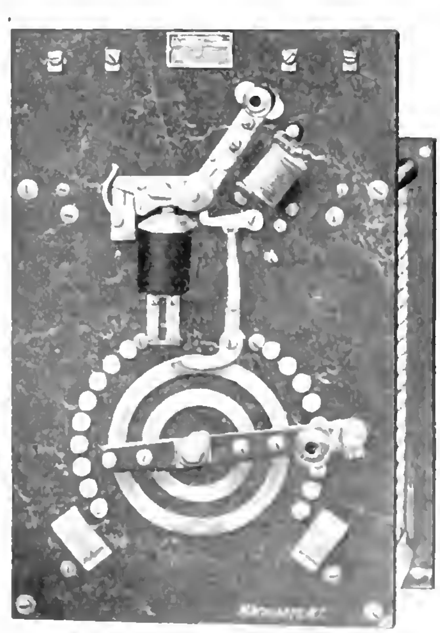


Fig. 8.

The operating lever S carries contacts 9, 10, 11, 12, 13, 14, 15. Of these, 9 and 10 are connected with each other as indicated by line *s*; 11, 12 and 13 are also connected with each other, by the lines, *t t*. Contacts 14 and 15 are connected by line *Z*. All these contacts are insulated from lever S. The current passing from line *P* reaches the innermost contact ring 1, and if lever S is rotated clockwise, the contacts 8 and 9 will carry the current to segment 4. From this segment the current passes to the left side of the motor armature and returning from the

right side reaches segment 3. From segment 3, through the contacts 11 and 12, the circuit continues to the small contacts *m m*, with which the armature starting resistance is connected. Passing through these resistances the circuit reaches segment 5 and thence the line, *N*. If the operating lever 8 is turned counter-clockwise, contacts 9 and 10 will connect 1 with 3, and thus the current will reach the armature through the right side, and cause it to rotate in the opposite direction.

When lever 8 is in the central position, as drawn, the field circuit starting from line *P* reaches ring 2, and through contacts 14 and 15 and connection, *Z*, it reaches segment 7, which is connected with line, *N*. When lever 8 is rotated in either direction the first effect is to cut out the starting resistance, but after this is all cut out, contact 14 begins to slide over the small contacts, *n*, and thus cuts resistance into the field circuit, and the motor speed increases. As with the non-reversing controller, any motor speed desired, between the maximum and the minimum, can be obtained by advancing lever 8 until contact 14 is in the proper position.

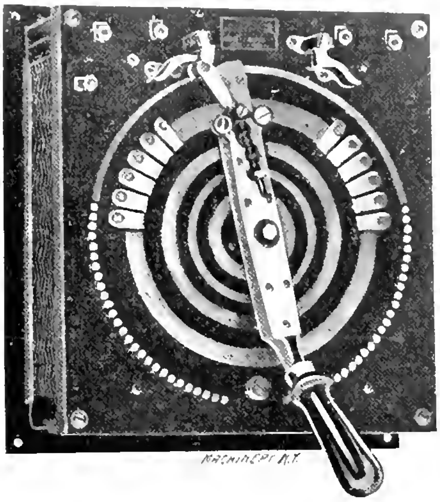


Fig. 5. Controller of the Reversible Type.

The Quick Make-and-break Action.

In Fig. 4 it will be noticed that the two contacts, 6 6, are connected with the end contacts, *m*. The contact 14 on the end of lever 8 is mounted upon the end of a lever that is pivoted to the back of 8 and is free to move sidewise against the tension of a retaining spring. This construction is clearly shown in Fig. 5. At the inner ends of the contacts, 6 6, are located latches, insulated from the contacts. When the operating lever 8 is turned to start the motor, this lever that carries contact 14 presses against the latch on 6 and is pressed back against the tension of the spring, until it is deflected enough to swing past the latch. It then flies forward and strikes the contact arc, 6, quickly, and with considerable force, thus insuring a good contact. This contact is made before 12 reaches the first *m* contact. In stopping, the action is the same with the exception that the lever that carries 14 is bent in the opposite direction until it can swing free from the latch on arc 6. It then moves rapidly and gives a quick break. In stopping, contact 12 passes off the *m* contact after 14 has connected with 6 but before it separates from the latter, and hence the circuit is broken between 14 and 6.

Other Forms of Controllers for Variable-speed Motors.

Fig. 6 shows another form of variable-speed controller which is a combination of a standard automatic motor starter, and a standard field regulating rheostat, mounted upon the same panel and provided with an interlocking lever to prevent starting the motor with any of the field resistance in circuit. The operation of this controller is made more clear by means of the diagram, Fig. 7.

Looking at Figs. 6 and 7 it will be seen that the operating lever, *D*, is provided with a catch, *v*, and that the rod, *L*, pivoted at *t*, engages with this catch when the parts are in the position shown. To move *L* out of the way so that *D* may be rotated and the motor started, it is necessary to turn the field regulator wheel until the lever, *K*, strikes *L* and moves its lower end to the left. Thus *K* must be returned to the position that cuts out all the resistance *r*, before *D* is free to move.

The interlocking arrangement shown in Figs. 6 and 7 is made use of by the Ward Leonard Company to provide reversible controllers with the protective devices of Fig. 1, that is, with the circuit breaker and the retaining magnet, so as to stop the motor if the current becomes excessive, or return the controller to the stop position if the current dies out. An arrangement of this kind is shown in Fig. 8 in which a reversing controller arranged for speed variation by means of armature resistance is provided with the protective magnets. In this construction the operating lever, *D*, is provided with a catch which engages with the hook on the end of the interlocking lever, if the lever, *D*, is returned to the stop position, and the interlocking levers are in the position shown. This is the position they will be in if the lower switch is in any but the vertical position. This latter position of the lower lever is the proper one for starting, as it cuts all the resistance into the armature circuit, and also draws the interlocking latch down so that lever *D* may be moved forward to start the motor. Hence, if the lower lever is in the proper position, which is the vertical one, the lever *D* can be moved forward; otherwise it cannot.

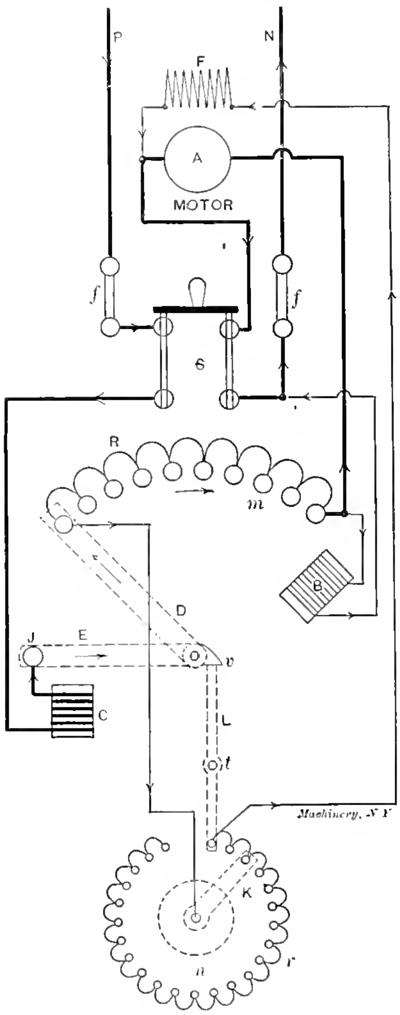


Fig. 7. Diagram of Controller, with Interlocking Device (See Fig. 6).

* * *

The vineyardists of Southern France have found a peaceful use for the "villainous saltpeter;" instead of burning gunpowder to shoot their fellow men they employ it to cannonade the clouds. In other words, many of the communes now use small cannon for preventing the destructive work of hailstorms, it being alleged that the peculiar gyratory action of the upper air currents which produces hail, is broken up by the concussion of cannon-firing when intelligently directed, and in this way incalculable damage is often averted. It, however, is a moot question, and the people of adjoining communes, according to consul Covert, are by no means agreed as to the effectiveness of this—to us—novel practice.

ELECTRIC MOTOR DRIVE IN THE NAVAL GUN FACTORY.

The 14- and 16-inch gun lathes in the Naval Gun Factory at Washington, D. C., have recently been equipped with Crocker-Wheeler motors, as illustrated in the accompanying cuts, Figs. 1 and 2. Fig. 3 gives a general view of the main aisle of the gun factory, showing the arrangement of the lathes at work. Fig. 4 shows the aisle or bay, at the right of Fig. 3, possible a very compact arrangement, the motor drive being confined to practically the same limits as required for the discarded cone pulley. Since the speed range required on the lathes is approximately 10 to 1, it was necessary to add a back gear run having a ratio with the direct run of 2.8 to 1. The change from one run to the other is made by means of a double jaw-clutch operated by a vertical lever shown at the left of the motor, and directly beneath the clutch collar,

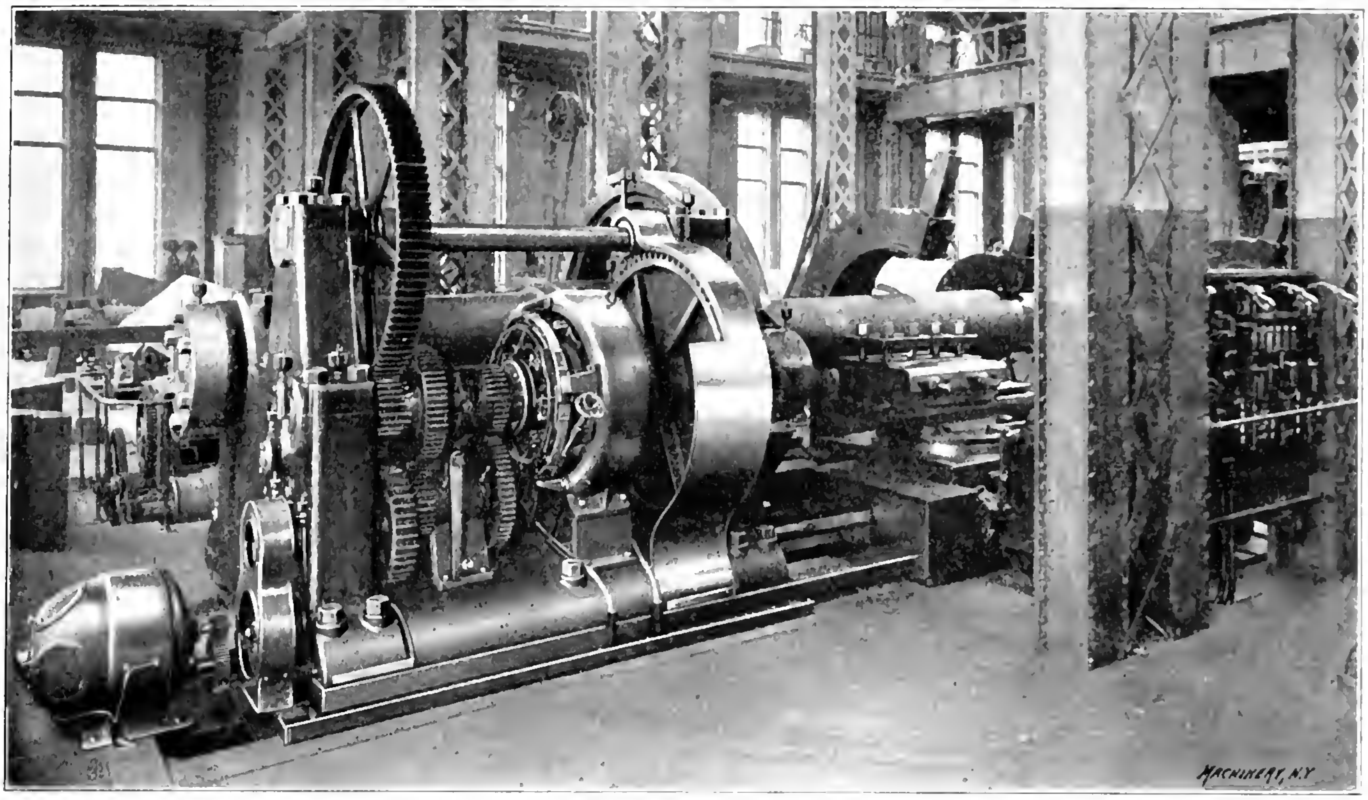


Fig. 1. Electric Motor Drive and Solenoid Switches applied to 16-inch Lathe in the Naval Gun Factory, Washington, D. C.

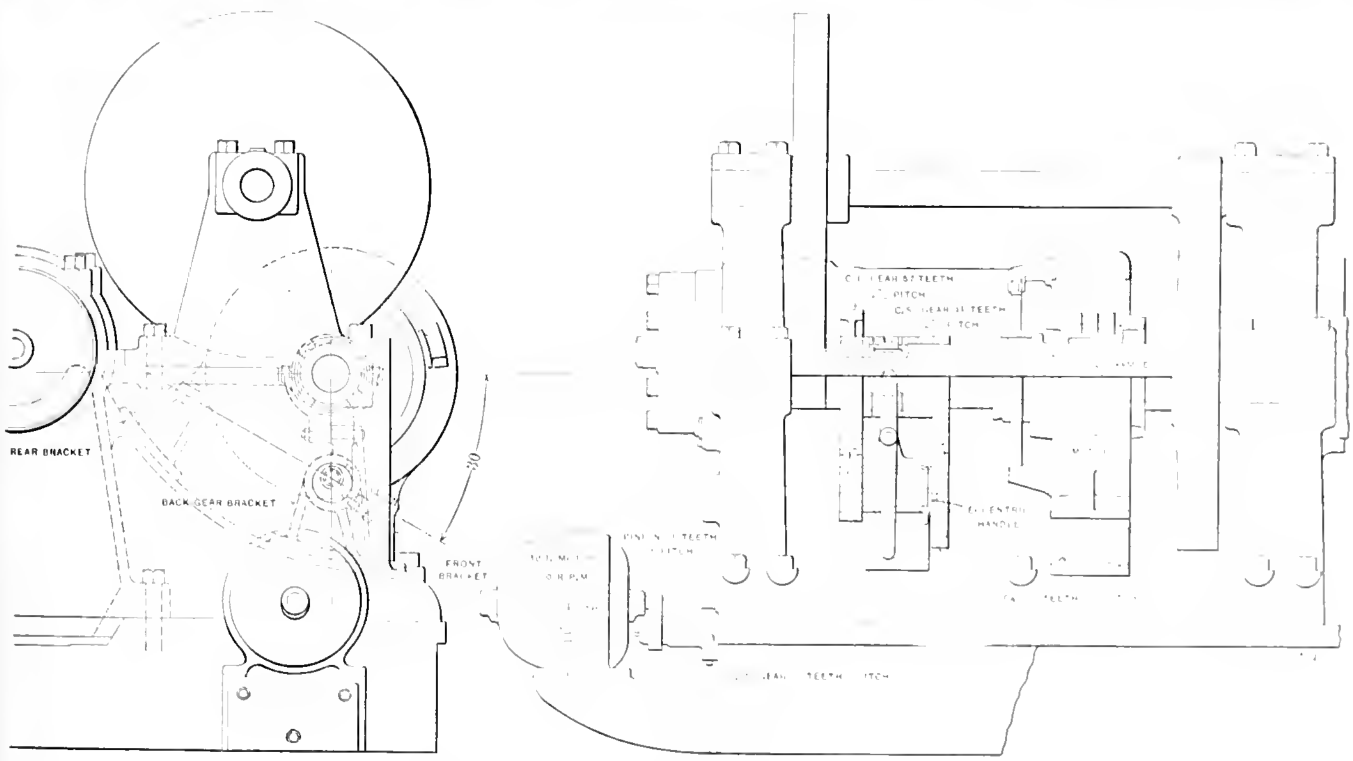


Fig. 2. Details of Electric Motor Drive for 16-inch Gun Lathe

at the headstock end of the lathes, and is intended to give an idea of the rope and belt drives which are displaced by the individual motor drives.

The main driving motor is of a special type built into the headstock, with the armature replacing the old cone pulley. This construction requires an especially large armature bore because of the large diameter of the faceplate pinion shaft that passes through it, and on which it revolves; but it makes Fig. 2. When using the fastest or direct run the back gears shown below the faceplate pinion shaft are thrown out of mesh by means of an eccentric lever in the manner common to ordinary engine lathes. Driving direct, the motor's working speed range is from 444 to 183 revolutions per minute, giving an extreme ratio of 2.4 to 1 in twelve steps. Throughout this range the motor will develop 30 horse power. Although lower faceplate speeds can be obtained by running

the motor slower, the power capacity of the motor would be reduced nearly in proportion to the reduction in speed. By throwing in the 2.8 to 1 back gear, the lower faceplate speeds can be obtained with ample driving power, since on the back gear run the power demand diminishes in proportion with the speed; the motor, then, of course, has ample power, and may run at any speed and yet be sufficiently powerful for all demands of the work. In other words, the demand for power is less with the slow cuts even though they be heavy and give the false impression of requiring great power. Therefore, using a motor speed range of 444 to 118 revolutions per minute, or a ratio of 3.75 to 1 on this run, gives a total faceplate working speed range of 10.5 to 1 with a possibility of increasing it to 21 to 1, by using even slower motor speeds, if very slow speeds are desired, as when setting up work, etc.

The speed variation of the motor is obtained by the use of the Crocker-Wheeler standard four-wire multi-voltage system, the maximum voltage between the outside terminals being 220 volts (see MACHINERY, June 1904, Engineering Edition). The controller is placed near the tool carriage, convenient to the hand of the operator. The controller proper, which is of the drum type, makes the proper voltage and field-weakening combination for each desired speed, but the main circuit is always broken outside the controller by two solenoid switches shown indistinctly at the right of Fig. 1. On passing from one voltage to another, a third solenoid switch is caused to open, thereby throwing resistance, called buffer resistance, into the main circuit, which prevents any undue rush of current that might otherwise occur. Having fulfilled its function, this resistance is automatically short-circuited at the end of a second or two. There are also two small solenoid switches so arranged that should any of the line voltages fail, the main switches will open and they cannot be closed again until the controller drum is placed in the "off" position. Push button switches are located at different points on the lathe for the purpose of making quick stops should such emergency occur.

The small semi-enclosed motor shown at the end of the headstock in Figs. 1 and 2 is a 10-horsepower shunt motor for giving a quick traverse to the tool carriages, and only used when traversing the carriage at high speed, as is desirable when shifting from one part of the work to another, etc. The feed and screw cutting motions are, of course, derived directly from the gearing driving the faceplate. The specifications for the 16-inch turning and boring lathes, which were built by Wm. Sellers & Co. some years ago, state that the bed is 73 feet 10¾ inches long, 9 feet wide, and 2 feet deep, and is made in two sections. The lathe was designed to give a safe cutting pressure of 140,000 pounds on 50 inches diameter when running at .4 R. P. M. An interesting feature of this lathe is that the tool carriages, of which there are two, are fed along the bed by a long nut revolving on a 6-inch steel screw fixed in the headstock and at the far end in the tailstock end of the bed. The carriage nut receives its feed motion from a square feed shaft driven from constant gears on the headstock, and its quick traverse from the small motor already described.

Fig. 3. General View of Main Aisle, Naval Gun Factory, showing Arrangement of Lathes at Work.

* * *

A neat method of keeping small miscellaneous screws and bolts in convenient and orderly shape for use in the shop, is employed by the Arthur Company, New York. It makes use of large glass tumblers of the jelly glass type, with pressed metal tops. The character and quantity of screws in each glass may be seen at a glance, and a desired screw can be selected from a large number of glasses with but a fraction of the mental effort required with labeled metal dishes.

SOME FAULTS OF INDEXING.

LEICESTER ALLEN.

Is the indexing of books a lost art? One would almost be inclined to affirm this after inspection of many modern books, testing their indexes by a comparison with their contents. Not only is this true of the books intended for regular perusal, but it is a sin that cries aloud in technical books required for occasional reference, and one that "smells to heaven" in books specially designed, and wholly used, for reference. No waste of time is so annoying—one might say exasperating—as that which is compelled while it is of a nature easily avoidable. Why it is that authors will expend untiring labor to gather and arrange the most valuable data in a book, and then send it to press with only a general table of contents for the various chapters, with no index whatever, or, at the least, an index so meager as to be almost worthless, is a puzzle for the practical mind. As well might a commercial man carefully fold, endorse and sort out letters, bills, invoices, statements, contracts, etc., and place these documents in a hundred separate pigeon-holes, without labeling the pigeon-holes. To find some particular paper one does not wish to be compelled to examine the contents of one pigeon-hole after another, till the right one is found; but the indexing of many books appears to be done on this principle; and quite often a general table of the contents of each chapter is thought sufficient. A business man could put up his deeds, bonds and

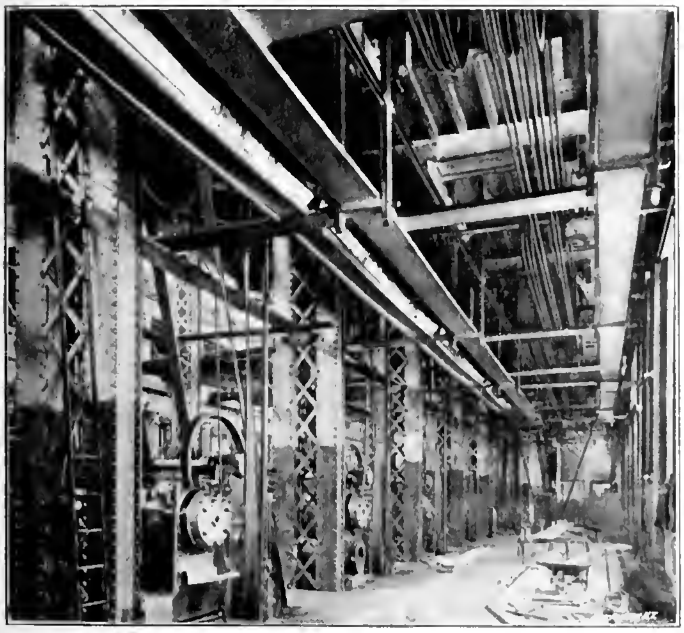


Fig. 4. Side Bay, Naval Gun Factory, showing the Belt and Rope Drives that were Displaced by Electric Motor Drives.

mortgages, letters and what-not into bundles, and tumble the different sorts into boxes or drawers and label the drawers; then, to get any particular paper, examine the entire contents of each box or drawer. But would any sensible man be content with such a system? Would such a jumble be worthy the name of system?

One book in particular is a conspicuous example of want of thoroughness in indexing. It will not be named here because this protest is raised against a general neglect and is not directed to single instances; but this book is a most useful example as illustrating how an otherwise most valuable compilation may fall far below its possibilities, simply from perfunctory work in its index. In this book are gathered together a surprising number of standard data, which in their entirety no engineer can carry in his memory, and as a handbook, the completeness and accuracy of its contents are not excelled in technical literature. But frequently a half-hour or even a longer time has been necessary to hunt down some item, known to be somewhere secreted among the great mass of material, simply because the index is an inefficient help. In some cases the matter in a paragraph, deemed of sufficient importance to have a capitalized heading, is not included in the index at all, unless its inferential inclusion in an indexed subject having a more or less remotely related title be called indexing. Although the use of the barometer in evaporative experiments, and other practical work, is referred to in various places in the text, the word "barometer" is not in the index. In one instance, a paragraph of nearly three hundred words on an important topic, has a heading in capitals containing three substantive words, each of which is of fundamental importance, and only one of these is in the index, while it there directs to a page treating of a widely different topic. If this were a solitary instance it could be excused; but it is probably one of a hundred or more similar faults, since, in using the book, not to find what is sought at the first effort is a usual result, and it is not uncommon to fail even at a second or third attempt; while to find some important data, one may abandon all hope of aid from the index, and roam through page after page in places where it might naturally find a fitting place, wasting time and patience. Nor is this a fault peculiar to the single book alluded to. This book is one only of a multitude of sinners. The indexing of English, German and French books is in general much more thorough than is the case with American books.

A common fault in indexing, where a topic is treated or referred to in some material relation to other subjects on a number of different pages, is to index the subject once only and follow with the pages on which some remark is made about it. This will be made clearer by an example. Opening the first book at hand, which happens to be a treatise on Heating and Ventilation, and which is only fairly well indexed, one of the listed topics is "Time required to heat buildings (pages) 256, 263, 286." On page 256 is a statement of the fact that when a building is to be intermittently heated, the capacity of the heating apparatus must be decided upon with reference to the time which can be allowed for preliminary heating before occupation. On page 263 is found a method of computing the time required for heating the walls of buildings. On page 286 is an account of the time required to heat a massive church building, as determined by actual experiment. Now suppose a person desires to find what is said upon any one of these topics; nothing in the index warrants that—although he knows the matter is in the book yet is not perfectly familiar with it, or if he has not used the work for some time—he will not be obliged to look in three separate places to find what he seeks. And if, in addition, he desires to find what is said of the time required for preliminary heating of buildings by stoves, he will not find this anywhere in the index, either under the word "stoves" or "buildings," or the title previously quoted, or under "heating," but will simply have to grope for it, like a child hunting for strawberries in a meadow. If his patience holds out he will find it on still another page of the book. It was easy to find this defect in a better index than is common with books of this class, and more might be as easily found. It would have taken the author of this book scarcely more time to have remedied each defect than every one of a majority of its thousands of readers wastes, time and again, in finding what he wants in similar cases.

The minds of men do not all work alike. In a technical paper is an article entitled "Extensible Planer Clamp Block." After the reading and laying aside of this article, say by twenty readers, to five of ten the word "Extensible" will be the word by which the pigeon-hole of memory will have been unconsciously labeled. Going to an index they will naturally seek that word, and should there find the complete title. Others will call up in memory the word "Planer," and looking in the index should find "Planer clamp block, extensible." To others the word "Clamp" will be the first to recur, and looking for this they should find "Clamp block, extensible planer." Every substantive word in the title of a topic will be found in a really good index. No reader should be compelled to look four times in an index to find any subject, if he looks for it in any natural, legitimate place where it might be placed. The fact that it might properly be so placed is proof that it ought to be there.

Another defect in indexing books, which some authors seem to favor, is indexing by paragraphs instead of pages. On the average it absorbs nearly twice the time to find matter so indexed as is needed for work with a page index. To find a

page one looks always at a place common to all the pages, most commonly the upper corner; to find paragraphs, one must scan the entire left-hand margin, and if, as often happens, the paragraph includes two or more pages, more time is consumed. The indication of both page and paragraph, if the work be well done in all other respects makes the most complete index; but it is probable that in the small number of such indexes extant very few literary workers use the paragraph numbers, or find them a material help.

It may be objected that such thorough indexing as is herein advocated, would make the indexes too voluminous. It would in many books more than double the number of pages required for their present indexing, and increase the cost of publication. As to the bulk, we reply that no index that does not repeat itself is too bulky for a work designed for constant reference. As to increasing the cost of publication, the objection holds; but if an increase of, say, five per cent, doubles the value and convenience of a literary tool, it is money well expended. A saw is one of our most efficient cutting tools, if it has a good handle, but while the blade may be of the very best quality, with its teeth filed and set to do the best work, if it has no handle, or only a make-shift handle, its usefulness falls far below its normal possibilities.

The defects named are also found in the card indexes now so much in vogue, excepting those in leading public libraries, the latter as a rule, being extremely good. How many whose work has required laborious research in these institutions have failed to recognize the fact that a good index supplies perfect and efficient handles to the literary tools with which they work?

* * *

IMPROVED LATHE OF THE TURRET CLASS.

Realizing that the modern turret lathe is more or less handicapped in the use of cross-slide tools, Mr. W. L. Cheney, Meriden, Conn., has recently secured a patent, No. 777,181, for a lathe design which increases cross-slide facilities. The object of the patent, therefore, is to enable an increased number and variety of cuts to be taken simultaneously upon work. In his patent specification Mr. Cheney details some of the objections to present designs of turret lathes substantially as follows:

"In turret lathes and machine tools of that class the slide-rest which is usually placed between the turret and tailstock or headstock, is oftentimes in the way of the turret and other tools, and the latter are in consequence required to be lengthened in order to reach over the slide-rest, thus making them unduly long and hence not sufficiently stiff for some purposes. In certain forms of heavy lathes a cross-slide has been placed on the turret itself whereby the latter may be rotated to get the cross-slide out of the way so that the turret may be moved up close to the headstock, thereby enabling the use of short tools on the turret; but in such lathes the cross-slide cannot be used at the same time that boring or other work is being done

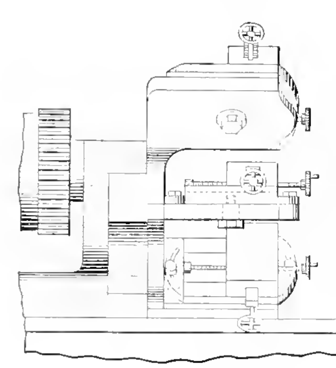


Fig. 1.

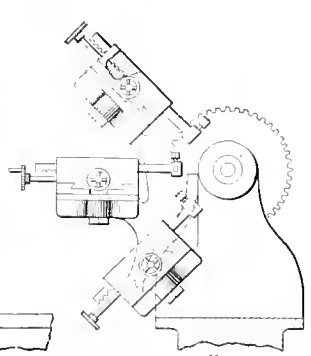


Fig. 2.

by the turret tools. In some other lathes the slide-rest is formed so that it may be run forward close to the headstock and beneath the work-holding chuck, but in this position it is of little or no use In all the machines referred to only one crosshead tool can be cutting at a time."

Figs. 1, 2 and 3 show diagrammatically the essential features of the invention, the idea being a multiplicity of cross-slides mounted upon the headstock so that the periphery of the work may be attacked independently of the turret tools. The drawings show the slides on the front of the headstock, but it is the intention of the inventor to balance them with slides on the back, which, of course, increase the capacity of the machine, and tend to equalize the pressure upon the work spindle.

* * *

CORRECTION OF A CALCULATION "IN ECCENTRIC LOADING."

Editor MACHINERY:

In the September issue of MACHINERY, under the head of hydraulic punch and shear, an error occurred in the calculation. As the subject of eccentric loading is important, the following correction should be noted. (In connection with this refer to Fig. 5 in the original article.)

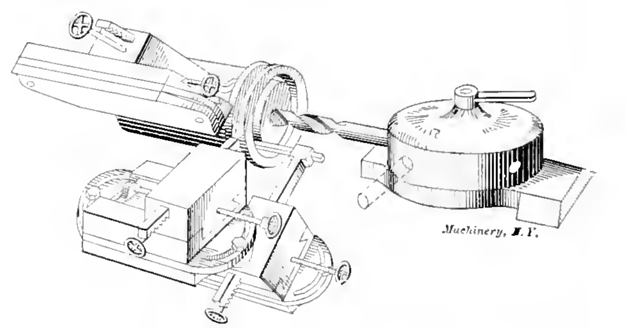


Fig. 3. Diagram showing Multiplicity of Simultaneous Operations on one Piece.

Capacity of machine, 100,000 pounds.
P = force acting on hooked portion of the housing = 100,000.
L = 2 inches.
$t = 1\frac{3}{8}$. We then have

$$S_t = \frac{P}{A} + \frac{PLt}{I} \quad \ldots\ldots\ldots\ldots\ldots (A)$$

$$I = 2\left(\frac{bh^3}{12}\right) = \frac{bh^3}{6}$$

Substituting these values in equation (A) we obtain

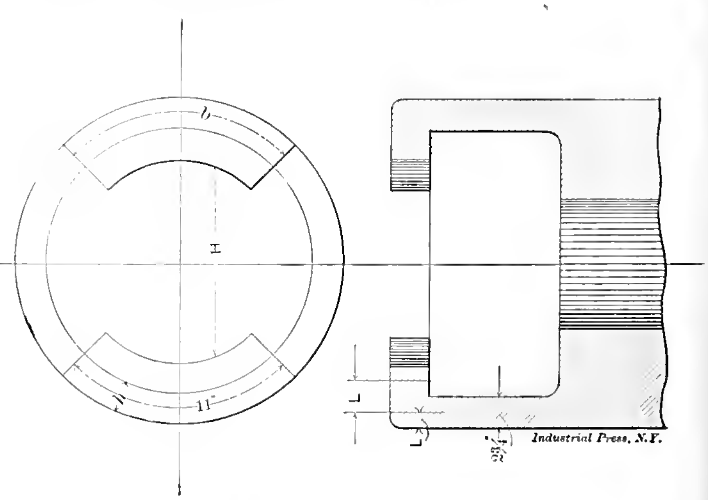


Fig. 5. (See original article in September, 1904, issue.)

$$S_t = \frac{100,000}{2\frac{3}{4} \times 11 \times 2} + \frac{100,000 \times 2 \times 1\frac{3}{8}}{\dfrac{11 \times (2\frac{3}{4})^3}{6}}$$

$$= \frac{100\,000 \times 11}{4 \times 11 \times 2} + \frac{100,000 \times 2 \times 11 \times 6 \times 4 \times 4 \times 4}{8 \times 11 \times 11 \times 11 \times 11}$$

$$= 1652 + 7220$$

$$= 8872$$

This is considerably more than the allowable stress for cast iron in tension. In addition to this excessive stress, these parts were machined and the outer skin of the casting, which is always tough and sound, was removed. This would undoubtedly reduce the strength somewhat.

Pittsburg, Pa. FRANK B. KLEINHANS.

DRAFTING ROOM PRACTICE.

RALPH E. FLANDERS.

The drafting room may be said to bear a double relation to the shop. It is the place where designs are originated, and so in a sense it is the head of the shop, furnishing it with the ideas which the machinist turns into concrete forms in iron and steel. On the other hand the drafting room may be the servant of the rest of the establishment, doing its calculating and its routine work of testing, etc., lessening the tax on the memory, and leaving the minds of the workmen and foremen free to the task of getting out the product. In different shops, the use which is made of these two functions varies—one or the other of them may be neglected. It is safe to say, however, that there are scores of shops where the drafting room is looked upon as an almost unnecessary evil, and grudged every cent which is spent in its salaries and supplies, when this part of the plant might be the servant of the whole, making the work go more smoothly and easily all along the

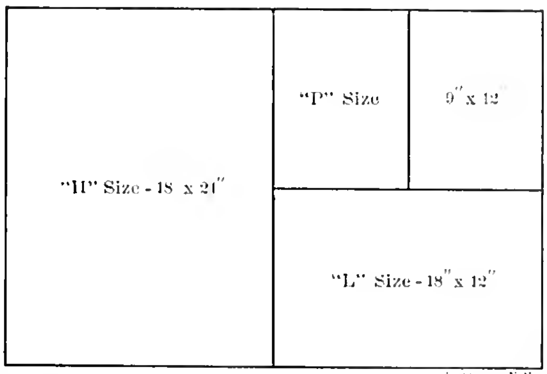


Fig. 1. Standard Size Drawing Sheet that may be cut into smaller Sizes.

line, from office to shipping room, if the men in charge understood how to get from it its full value. It is this second function which is perhaps least understood. In this article the writer will endeavor to show some of the different ways in which the drafting room may lighten the labors of the workmen, lessen the strain on the foremen, and grease the wheels of industry generally. We will neglect entirely the matter of design, therefore, and consider the routine office work of a typical shop. All the ideas which will follow have been put into practical and satisfactory use, some of them for years in the largest establishments in the country, while others have been worked out in the writer's own experience.

Systems will vary greatly in such widely varying lines as fire-arms, electrical apparatus and milling machines, but in order to take a case which will be most suggestive to readers of this journal, suppose it is required to equip with all necessary drawings, lists and records, a small shop building a line of machine tools.

Numbering the Parts.

We should have to start with a layout of the machine in hand, done to accurate scale, made either as a new design or a copy of a machine already being produced. The first question to consider is that of numbering the parts and arranging the detail drawings. A good way to number the parts, drawings, patterns, etc., is to give to each variety of tool produced a distinctive letter, such as "A" for universal mills, "B" for plain miller, "C" for vertical miller, "D" for shaper, and so on. Attached to this is a number distinguishing the size. "B2" is No. 2 plain miller, "L24" might be 24-inch lathe, and so on. The men in the shop and office alike soon fall into the way of calling the machines by these nicknames. Then each separate part is given a serial number. Thus "L20-49" might mean the back gear guide for a 20-inch lathe. This designation would be marked on the pattern and serve as a pattern number as well.

The arrangement of the parts in order for numbering depends on whether the parts are to be manufactured and fitted in assembling, or fitted each to the other in the process of making. We may take it for granted that the shop is trying at least to do business in a profitable way, so the arrangement will be considered from a manufacturing standpoint. The parts should then be grouped in such fashion that those having similar operations involved will be detailed on the same sheets. First will come the large castings, like the beds, legs, tables, heads, etc.; after, come the other small castings involving milling and drilling mostly, as the brackets, levers, braces, gear guards, etc.; then the castings which are finished mostly by turning, like pulleys, gears, and bronze bushings. Next comes the group which includes the turned parts made from stock or forgings, such as spindles, shafts, steel gears, etc.; followed by a group of the small parts made on the screw machine. The last class contains the parts made by milling and drilling from flat and rectangular stock. If the parts are numbered and arranged on the drawings in some such order as this the workman who makes a specialty of certain operations will have all his work conveniently grouped together on the sheets.

Standard Drawing Sizes.

To obtain the greatest simplicity in handling and indexing in the drawing office, it is necessary to have a single standard size for the sheets. In the shop, however, big blueprints are a nuisance, and the sheets should be no larger than is needed to show a convenient number of the parts in the group being detailed. It is possible to satisfy the requirements of both shop and office by making the tracings of a standard size, and cutting the prints up afterward into as many smaller sheets as may be necessary. Fig. 1 shows how the convenient 36-inch x 24-inch "D" size sheet may be cut up into the other smaller sizes; thus it may make 2 "H" sheets, or 4 "L" sheets, or 8 "P" sheets, or 2 "L" sheets and 4 "P" sheets, and so on. The smaller size is especially suitable for the parts made on the screw machine. If an extra large sheet is needed for an assembly, or a full-size view of a large casting, a 36-inch x 48-inch sheet, or larger, may be made, folded into the standard sheet dimension, and filed with the rest.

Detailing.

Starting in the order in which the parts have been grouped, detail them out on large sheets sub-divided to suit the case in hand. Don't try to crowd them, but give plenty of room for changes and additions, and leave space in each drawing for adding other parts of a similar group, if this should be required in the future. The lower right-hand corner of each

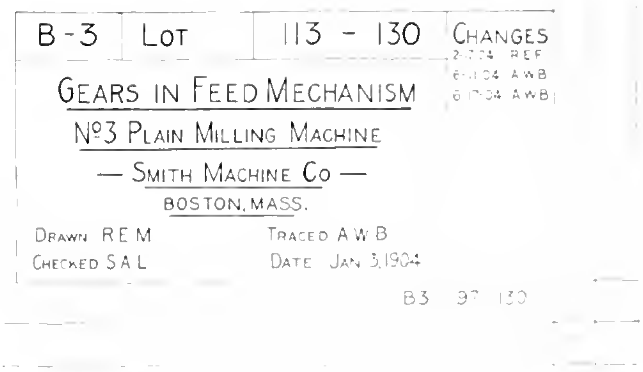


Fig. 2 Lower Right-hand Corner of Drawing

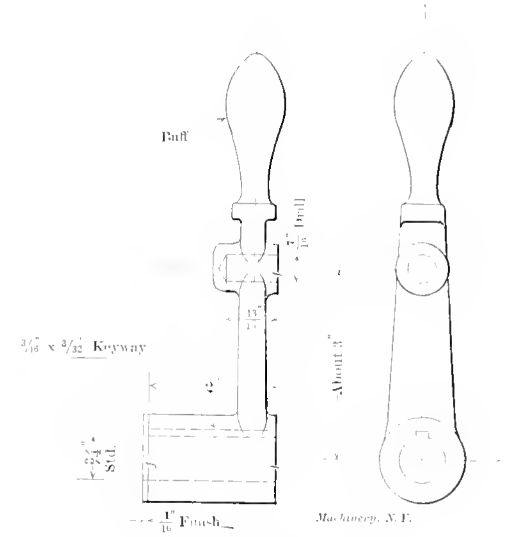
section is ruled off into a title, as shown in Fig. 2, containing on the top line the symbol of the machine, in this case B3, which means No. 3 plain miller, then the lot number, which is filled in on the print, and lastly the list of part numbers included on that drawing. The second line contains in large letters a title descriptive of the contents of that drawing; the next names the machine, and after that comes the firm name and the space for initials and dates. The column at the right, headed "changes," will be explained later on.

In assigning numbers to the parts, leave a few numbers out at the start to give to the assembled drawings when they are made. Begin by numbering the column, say, No. 15. Leave out two or three numbers, to give leeway if it is desired to add any new details to that sheet later on, and then number the knee and saddle, for instance, if they come next, 19 and 20. The first sheet then would include Nos. 15 to 18, and so 15-18 would be printed in the proper space in the top line. The drawing with the knee and saddle, containing only these two details might be numbered 19-23, and so on. In the same

manner, if the first group ends at 60, begin the next group at 100; that might end at 271 and the next begin at 300, and so on. Thus parts and drawings will be numbered in a flexible way which will make additions easy without deranging the list of parts. In the margin at the lower right-hand corner of the sheet should be placed the numbers inclusive of all the details on all the drawings of that sheet, as shown in the sample title, Fig. 2. This is for convenience in filing the tracings.

Dimensioning.

In detailing, the way in which the parts are dimensioned, the completeness of the information given by the dimensions and the notes, and the clearness of the drawing itself, all these points together make the difference between help and hindrance. Much has been written in mechanical papers, and much more said in the shop, profanely and otherwise, about the dimensioning of drawings. The draftsman must keep in his mind's eye the whole course of the manufacture of the piece, and give the dimensions in such shape that the workman will not have to add or subtract or multiply or divide this and that to obtain the measurement he requires. Of course no scaling of drawings is allowed in the shop. The ideal to be kept in mind is that of a drawing having information so completely given that the wayfaring man, though a fool, need not ask questions, but take the blueprint, follow it in blind confidence, and turn out work all completed save for the little squaring up of shoulders that may be needed in fitting it in place in the machine. In Figs. 3 and 4 are shown detail drawings, which more or less completely illustrate this idea.



NO. 71-FEED CHANGE LEVER.
1-CAST IRON.

Fig. 3. Detail Drawing

Fig. 3 shows a cast-iron lever. The handle is not turned, but buffed, as noted. Since the body part has no finish given, it is painted to correspond with the rest of the machine. The ends of the hub and the face of the boss are marked "*f*," which means "finish." This idea is sometimes carried out more completely by making f^1, for instance, mean a ground surface, f^2 a filed surface, f^3 a smooth-turned, but it is much less confusing to write out in plain English, whatever finish may be required other than that left by the cutting tool. Do not be afraid of putting in the drawing any notes which will aid the operative. "Finish" is often indicated by a red line about 1-16 inch outside of the finished surface and parallel with it. This is the best and clearest way on paper drawings, and blueprints as well, when the red lines print well, but it takes good paper and careful printing.

The dimension from the center line of the hub to that of the boss is marked "about 3 inches." This means that the centralizing of the holes in the casting is of more importance than the actual dimension given. The hole in the hub is marked "¾," "std.," or "standard," which means that it is to be reamed to fit a standard plug gage. The hole in the hub is marked "drill," which shows that it is not to be reamed or bitted, but left as the drill leaves it. It will be noticed that a "fit" of 1-16 inch is indicated at one end of the hub. The workman who squares up the casting at this point must leave 1-16 inch for the fitter to remove in putting the machine together. In the same way "fit" is indicated on the drawings of all shafts, etc., where it is necessary to square up a shoulder to make an end fit. This relieves the lathe hand of all speculation as to where his fits come. Under the detail are placed the part number, the name, the material of which it is made, and the number wanted for each machine.

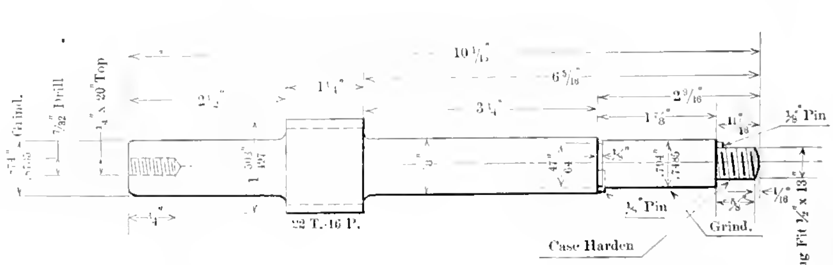
There are no casting or pattern dimensions given in the detail. It is an unmitigated nuisance to have the shop drawings obscured by a maze of dimensions which are never used but once, when the pattern is made. These pattern figures may be placed on the paper drawing from which the tracing is taken, or they may be put in with a yellow pencil on a blueprint taken specially for that purpose. Of course when it is necessary for a finished surface to bear a definite relation to a rough surface, dimension lines may be drawn from that point, but otherwise the shop should have to do only with the finished surfaces.

The detail drawings for the patternmaker should show the draft plainly wherever it is required, show the manner in which a finish cut terminates in the rough casting, and, in general, give a true picture of the piece as it will look when finished in cold metal. This relieves the patternmaker of all guesswork as to whether he ought to add or take off the draft, and, when combined with careful patternmaking, furnishes a record of the exact shape of the castings, which will be useful in estimating clearances in future changes.

Fig. 4 shows a sample detail of a steel pinion and shaft. Limits are shown for all the diameters. The determination of limits calls for good judgment on the part of the draftsman. It is very natural for him to put the standard much too high, while the shop often complains of the closeness called for, not realizing that by the old cut-and-fit method much closer work was done than is needed or called for under the limit system. Limits may be expressed in two ways. For instance, a running fit on a shaft to go in a 1¼-inch standard hole in a bronze box may be marked $1\frac{1}{4}\begin{cases}-.001 \text{ max.}\\-.0015 \text{ min.}\end{cases}$

or it may be expressed $\begin{cases}.249\\.2485\end{cases}$

The first way may be best for shops where the workmen have not yet become acquainted with their micrometers, but it savors strongly of the "⅞-inch plus 1-32-inch less ½ of 1-64-inch" of our forefathers. In the better shops of the country the very errand boys learn to use the micrometer with ease and skill, so it would seem that the second method of marking the size ought not to puzzle the workmen very long. In either case the larger dimension should be on top, to catch the eye first. In places where there are no limits given, of course it is understood that good accurate scale measurement will do.



NO. 497 PINION SHAFT. 1-MACHINE STEEL.

INTERMEDIATE PINION SHAFT. 2-MACHINE STEEL.

Fig. 4. Another Example of a Detail Drawing.

On the drawing, the tap drill size and the depth of a tapped hole are shown. The two journals are marked "Grind," which means "grind to size"; the one into a plainly shown recess, the other, where the box does not come within ½ inch of the shoulder, up to the fillet. In general it is intended that the dimensions shall be so arranged that the lathe hand will be able to use them as they stand without bothersome calculation. On work made from the round or rectangular bar, finish marks

are omitted. If it is desired that the piece be left rough at any point, the words "stock size" may be applied to the figures describing that dimension. For instance, on a 1¼-inch cold-rolled shaft turned up for a short distance at each end, the central part would be dimensioned 1¼-inch "stock size." This particular piece is used twice in the construction of the machine, and in different localities, so it is given two names under the same part numoer.

Part Lists.

Two lists are required: A list of detailed parts, and a list of stock parts. Every single item of a given machine must be recorded somewhere, either on the blueprints or in the list of screws, washers and other sundries taken from the stock-room or purchased outside. A page heading for the list of parts in the casting group is shown, upper sketch, Fig. 5. The first column gives the part number; then comes the name, then the number wanted, the material of which they are cast, and lastly, two columns marked "castings ordered" and "order filled." These spaces may be conveniently checked by the one who orders the castings, and he will thus have a good idea at any time of what progress is being made in supplying the needed material. This does not, of course, take the place of whatever foundry order system may be in use. The page heading of the parts made from the bar and rod are also self-explanatory, the last two columns being filled in with the dimensions of the rough stock needed to make each piece. It will be remembered that numerous blank spaces were left in numbering the parts, to give room for future changes. Similar gaps should be left in the list of parts.

The "List of Stock Parts," of which two sample headings are shown, must cover everything not otherwise provided for, and give all the information necessary for ordering. Leave plenty of room here, as well, for additions and alterations. These lists may be done in ink on printed and ruled blanks of thin bond paper, or they may be typewritten for blueprinting in the following manner: Do the work in a good strong manifolding machine with a new black ribbon. A piece of carbon paper should be placed in back of the sheet with the face against it. This prints the back of the sheet as well as the front, and makes characters heavy enough to make blueprints in fine shape.

If these lists are printed, clipped together in tough paper covers, and distributed generally among those who have any use for them, they will save a vast amount of useless mental strain. Before a new lot of machines is ordered the stock-keeper can go through the list and see that he has every last screw and washer on hand that is needed. The man who orders the castings can look over the supply on hand and govern himself accordingly. The man who has charge of the bar stock can keep himself supplied with the necessary material, and cut it off of the proper cross-section to the proper length as fast as it is needed. The foremen in the shop can assure themselves that nothing has been forgotten, that everything is coming along as it is wanted, and have in general a constant reminder at hand of what is required of them.

Assembly Views.

After all this has been done, we may make the necessary assembly views, working entirely from our detail views and stock part list. If the parts all go together in good shape, it is an indication that the job will check up well. On these drawings, at least, and perhaps on the details, it is a good plan to use some simple method for distinguishing the various classes of materials by the cross hatching. It is good enough to have one style for steel and wrought iron, one for brass, bearing metals, etc., and one for cast and malleable iron.

Tracings.

Next comes the tracing. If the machine is a new one, never built before, it is a good plan to shellac the paper drawings and send them out into the shop for the first lot. This will make the inevitable changes easier to handle than when blueprints are used from the start. As soon as the machine is well in hand, the drawings may be recalled, cleaned with alcohol, and traced. It is of great importance to use the very best grade of tracing cloth. Not every well-advertised brand will stand the rubbing and scrubbing of a draftsman who has the fever of improvement seething in his brain. It costs much less to get the best tracing cloth at the start than it does to have to make new tracings on account of having cloth that will not stand erasure.

Checking.

The checking may now be done. It is best to delay this until after the tracings are completed, and then it is done once for all; and it can best be done by some one other than the man who did the detailing. If, however, it be gone over in some orderly, systematic way, it may be as well done in a one-man drafting room as in some large establishments the writer has seen, where the drawings are examined and initialed by every one in sight, from the engineer in charge down to the sweeper.

Think over beforehand every direction in which a mistake is liable to occur, and make a table covering these chances of error, and tack it in plain sight on the wall over the desk. For such a system as that we are considering, the following list might be appropriate:

1. General design.
2. Finish.
3. Dimensions; sufficiency and arrangement.
4. Dimensions; compared for accuracy.
5. Compare with list of parts.
6. Compare with list of stock parts.
7. Pattern number.
8. Notes.
9. General title.

That is to say, beginning with the first part in the list of detailed parts, we would examine it first for points in its general design. 1. Is it well proportioned, strong enough,

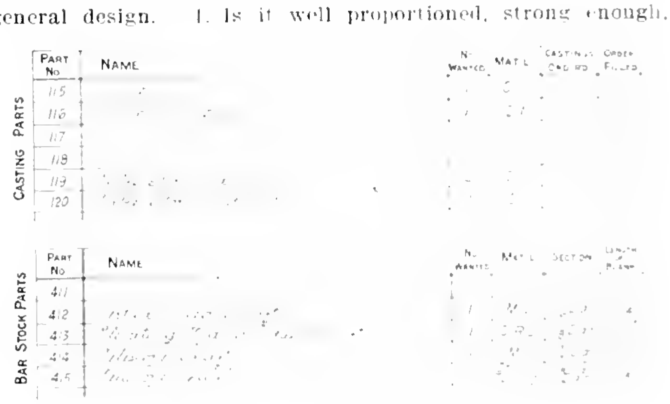


Fig. 5. Headings for Blueprints, giving Lists of Stock Parts

and in general harmony with the lines of the rest of the machine? Could it be changed so as to require less machining, or to make it cheaper to mold (if a casting)? 2. Is there any unnecessary finish, and has the needed finish been properly indicated? 3. See that the dimensions are sufficiently full, and arranged in such fashion that the workman will know, without figuring, the dimension he needs. 4. Compare the dimensions of the detail in hand with those of every single contiguous and related piece in the whole machine, whether detailed or given in the list of stock parts. This is the important item in the list, and if it is faithfully carried out it will double-check every dimension, as each part is thus checked up once individually, and again in the correcting of other related parts. 5. Compare titles and stock dimensions with entries in the list of detailed parts. 6. See that every stock part which is related to the detail being considered is properly entered on its list. 7. If the detail is a casting which has no pattern of its own, but uses that of some other part of the same or another machine, see that the proper pattern number is given under the title. 8. Be sure that notes are given, to supply the workman with all the information he needs as to fit, finish, etc. Otherwise he will worry the foreman with fool questions. 9. After the details have been checked, as above, see to it that the title of the drawing is correct as to part numbers, names, etc.

In the same fashion the lists must be gone over, checking every name, number, note and dimension.

Printing, Mounting, Etc.

The tracings may now be blueprinted, cut up into the proper sections, and mounted on suitable boards. Do not send them out rolled up, to get defaced and torn, and refuse to lie flat in

the files, when they are returned. Then they may be distributed to whoever needs them. With the details intelligently grouped as described above, and with not too many on a drawing, one set of detail prints ought to suffice to put through a single lot in the shop. Be generous with the lists, however, and put them wherever they can be of any service. Stamp each print, in red, with the date when it was printed, and keep a record of prints made and delivered to the shop. This record will be found very valuable when making changes as described below.

Changes.

In a shop which is alive the product is in a constant process of improvement, so it is necessary to make a full provision for this state of affairs in a good drafting room system. In the first place the men in the shop should on no condition be allowed to make an erasure or addition of any kind to the shop prints and drawings. If an error is discovered or an improvement found advisable, let it be reported at once to the draftsman, who should stand ready to make any needed change with promptness and good grace. In general practice, however, it will be found best, from the drafting room standpoint and that of cheapness of production as well, to delay radical changes until a new lot is begun. In some places the foremen and other prominent men are furnished with stub books in which they write suggestions for the improvement of the different lines of machinery. The leaf is filled out in duplicate with the stub, and sent to the drafting room, where it is considered either immediately or when a new lot is ordered, according to the urgency of the case. This scheme gives the draftsman the advantage of having all the "kicks" and helps in tangible form, for ready reference, and also gives the credit to the men who hold the duplicate stubs.

In the same manner that the checking was done it will be found advisable to make out a list of everything which might require attention in making alterations of any kind. The following table would cover about everything. This ought also to be printed and nailed on the wall in plain sight of the draftsman:

1. Detail tracings.
2. Assembly tracings.
3. List tracings.
4. All prints (detail, assembly and lists).
5. Patterns.
6. Special tools.
7. Record of changes.

In making a change, if it is at all elaborate, it is safest to sketch it out on detail paper before making changes on the tracing. In erasing tracings, use any smooth sand eraser which has been approved by experience, and place under the part being treated a sheet of some smooth hard substance like celluloid, sheet metal, or a round-edged piece of glass. This will remove the ink without giving the rubber a chance to deeply abrade the cloth itself. Cases sometimes occur in which a comparatively simple change, like shortening the over-all length of a complicated casting would entail a considerable amount of labor. To avoid this, the dimensions only may be changed, and then circled, as in the small sketch, Fig. 6. This gives notice to whomsoever it may concern that the dimensions are out of scale, so that the drawing will not measure correctly. Where the change is one of 1-32 inch or less, it is not advisable to alter the lines of the detail or circle the figures.

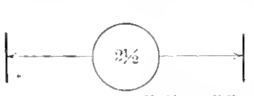


Fig. 6.

The assembled drawings should be kept up to date if they are to serve any purpose at all. In some cases it might be permissible to introduce circled dimensions on these tracings as well, where an otherwise small change would require much scrubbing. The lists also must be corrected, of course.

There are two ways of changing the blueprints, where the change is so small as to make a new print inadvisable. One way is to use the "soda solution" which acts chemically on the paper itself. This gives the most permanent results, but requires some skill in handling, as the lines do not appear until some time after the liquid has been applied. Chinese white, ground in water, can be used like ink, and easily removed when desired—so easily, in fact, that it is best to shellac the changed portion of the print to preserve the lines. With either method it is best to draw in the new lines first, and then obliterate the old ones with a blue pencil, this being the only known method of erasing on a blueprint. Be sure that every print of each tracing is changed—the list of prints charged out will tell you this. If new copies of a print are required on a change, destroy the old ones; do not leave them lying around, to cause trouble.

Patterns and special tools must be looked up for each individual case, and duplicate written orders made out for changes, one to go to the toolmaker or patternmaker, and the other to be kept in the office as a record until the work is reported finished.

LIST OF SQ HEAD SET SCREWS

NAME OF SCREW	NO WANTED	DIAM	L'GTH	MAT'L	FINISH	POINT
To hold Dog #89 on Shaft #417	4	3/8"×16"	1¾"	Steel	C.H	Cup
" " Rod #465 on Bracket #111	1	3/8"×16"	1¾"	Steel	C.H	Cup
" " Gear #126 on Shaft #439	2	3/8"×16"	1¾"	Steel	C.H	Cup
" " Stud #455 in Holder #97	5	3/8"×16"	1¾"	Iron	Soft	Oval
" " Roll #512 on Pivot #542	12	3/8"×16"	1¾"	Iron	Soft	Oval

LIST OF FURNISHINGS

DESCRIPTION	AM'T PER MACH
Single Belting - made Endless - First Qual - 1½" Wide.	13Ft.-7In Endless
Single Belting - First Quality - 1" Wide.	49 Ft
Round Belt - ¼" Diam - Furnished with Couplings.	3 Wanted - 11 Ft each
"Cosmolubric" Oil.	2½ Gall's

MACHINERY, N.Y.

Fig. 7.

Referring again to Fig. 2, there is shown at the right of the title a column headed "Changes." After each change is completed and checked up, the person making the change should enter here his initials and the date, in small legible characters. A "Record of Changes" book should be kept. Under the date signed in the "Changes" column there should be entered a brief description of the alterations, giving exact dimensions, and perhaps the reason for them as well. A separate book should be kept for each line of machines manufactured. By comparing the last change date on a print with that on the tracing it can immediately be determined whether or not the print is up to date. By referring to the given date in the "Record of Changes," the exact scope of the alteration can be found at any time. This will be found a great convenience.

In cases where an error has been made in the shop on a machine, and a deviation from the drawings in that particular case will save a large amount of costly labor and material, this change may be made; but it must be recorded, for convenience in making future repairs and attachments. It is the proper thing to number the machines of a given kind and size serially, beginning, for instance, by numbering the first 20-inch lathe built, No. 1, the next one No. 2, and the one hundred and seventy-eighth one No. 178, and so on, as long as the machines are built. This number should be stamped in a prominent place, and attention called to it in the catalogues and other printed matter of the firm. A book for a "Record of Machines Shipped" should be kept, with a page for each individual machine. This page is numbered with the tool's serial number, and contains information as to whom the machine was sold to, a record of the inspector's tests, a description of any change from the standard drawings used on other machines in the same lot, and a record of all attachments furnished, repair parts sent, complaints from user, etc. It is easy to see the value of such a record as this in furnishing new parts, remedying defects, and estimating the values of various designs.

After each lot of machines has been approved ready to ship, all the prints—detail, assembly, and lists—should be returned to the office. A complete set should be taken from them and the duplicates destroyed. File this set of blueprints away in a folio the size of the "H" sheet, doubling the "D" size to do this. As far as the work done in the home shop is concerned, this, with the office book, will furnish a record of each individual machine for all time, no matter whether it goes to

Lapland, or stays in the town where it was born. These folios should be kept indefinitely.

It is not feasible to try to make the tool drawings of jigs, special cutters, etc., on full-size sheet, even though divided, as the standard parts are. These should be made on a suitable standard size of a good grade of detail paper in a quick sketchy way, shellaced, and sent into the shop. Number these drawings with the symbol and part number of the detail for whose manufacture it is used, adding a serial number as well. This serial numbering is common to all tools made, no matter for what purpose, and is to be given them in the order the drawings come from the office. Thus if L 22-75 is the part number for the spindle of the 22-inch vertical driller, the finishing taper reamer for the hole in the same might be numbered L 22-75-193. If A-4-267 is the index wormwheel for the No. 4 universal miller, and the next tool drawing made is a hob for same, it would be numbered A 4-267-194. These numbers should be stamped or etched on the different tools as soon as they are made.

A book should be ruled up for a "List of Tools." A sample page heading is shown for this in Fig. 8. The tools are entered serially as fast as drawn. The first column gives the date when drawn, the main part of the page, the description. Next is a space for a list of parts for which this tool is used other than the one it was made for. As changes are made, old numbers are crossed off from here and new ones added, so plenty of space must be allowed. For convenience in finding the drawing, the last column gives the standard size of sheet on which the tool was drawn. It will be noted that one tool is marked "None." This tool was made in the shop off-hand, without any

DATE	TOOL NO	NAME	USED ALSO FOR	SHEET
2-17-04	H14-76-276	.498" Rose Reamer for bushing holes in Stop Slide	(H7-96) (K1-72) (L14-472)	None
2-17-04	B2-28-277	Jig for bushing holes in Gear Box		D
2-18-04	B2-28-278	Boring Bar for bushing holes in Gear Box	(G2-49) (H6-82) (L17-24)	L
2-20-04	L17-480-279	Gang Rack Cutter for Feed Rack	(L20-480) (L24-480)	P

Fig. 8.

drawing to go by, but it was entered on the list and its tool number marked on it, to give it a local habitation and a name. These tool and jig sheets should be filed in a drawer of their own, divided into compartments of suitable size, and all arranged with serial numbers in order, the lowest at the bottom. The jigs and tools themselves are best arranged with the serial numbers in order, since this will avoid constant rearranging as the stock increases. To find them readily an index list should be prepared, giving the standard machine parts in numerical order, and listing under each one all the special tools used in its production, whether those tools were originally made for it or not. Of course much of this system of keeping track of special tools is required only in shops where they are used in large numbers, but that may be taken for granted if the concern is in earnest about doing a profitable business on a large scale.

In cases of special machines or outside work of any kind, which does not come under the head of standard product, the same system may be followed as a whole, with the exception of the symbol for the machine, which should be given a serial number instead of the letter and size number of the regular product. A record of these serial numbers should be kept in the office, and the drawings filed away, if the job is important, in the same manner as the standard blueprints. Attachments to regular machines, made up separately, may follow the entire system for standard parts. The symbol describing them may be formed by adding a letter to the symbol letter of the machine. Thus AA-3 would be "Vertical Milling Attachment for No. 3 Universal Miller"; BD-4 would be "Rack Cutting Attachment for No. 4 Plain Miller," etc.

In place of the record books suggested, it might be better to use loose leaves, with punched holes, and held in [illegible]able binders. These leaves could then have proper entries made on them in the typewriter, and thus save hand work. It will be noted that in no case are there any forms used in such numbers as to require the use of printed matter, so the initial expense is small. Printed forms, card index systems, etc., may be evolved as the shop grows.

In recapitulation, a drawing office managed in some such way as this will give the firm the benefit of the following advantages:

Complete tracings and blueprints, easily filed and indexed, and made in such a way as to give the fullest, clearest information possible to the workman.

Complete list of parts as a convenience in tracing the progress of the work and keeping up the supply of raw material.

Complete list of all stock parts, for the benefit of the assembling foreman and the stock-keeper.

A list of all tools used for any given part, and ready means for finding the same, also means for ordering duplicate tools by number from the original drawings.

Means for making all changes entailed by changes in the product, in a simple, comprehensive way, and for making a permanent record of same.

A record of the suggestions made in the shop and office, for the drafting room in making changes, and for the firm in determining the relative value of their employes.

A full individual history, by means of the office record and the filed prints, of each machine built, useful in many obvious ways.

There are many men to whom the suggestions given above will seem the veritable A B C of the business; on the other hand, there are dozens of places where the suggestion of doing things in some such way as this would be considered a dangerous and revolutionary proposition. Practically all the work covered by a good system has to be done by someone, some time, and if it is not done decently and in order, it will be done in vexation of spirit, and with waste of time and money. The writer hopes that the suggestions here given may be of assistance to someone who has on his hands the task of starting a new drawing office, or the more discouraging job of inspiring with life the dry bones of an old one.

* * *

A long-distance pneumatic tube system has been proposed to transmit mail and express matter between Chicago and Milwaukee. This is a distance of 84½ miles, but packages would make the journey in only 40 minutes by the proposed tube, which would have a speed of about 120 miles per hour. The tube is intended to be 18 inches in diameter, laid entirely underground. It would convey loads up to 500 pounds, and would be run in relays of from two to three miles each, each section operating independently of the others, power automatically being cut off from a section upon the entrance of the mail carrier into the following section. The carrier would not be forced through the tubes by means of high pressure, as in other systems, but would be carried along by a vacuum. The cost of installation of such a plant would be $5,000,000, but the cost of operation and maintenance of the system would be so low that it is figured that the company could afford to carry 500 pounds for 15 cents.

As yet there are no long-distance pneumatic tube systems in operation, but contracts for several are now pending. Quite a number of systems of lesser length are now in operation in the United States, the longest of which serves the Chicago post office. This system is 9 miles long, and connects various postal and railway stations in Chicago with the old post office building. It has a capacity for carrying 3,000 letters per minute each way, and cost $650,000.

* * *

It is said that if steel is alloyed with manganese to the extent of 4 to 5½ per cent, it becomes so brittle that it can be pulverized with a hammer. A further increase, however, of manganese causes the steel to become ductile, yet very hard, the maximum degree of these qualities being reached with 12 per cent of manganese. A peculiar feature of manganese steel is that the ductility is produced by sudden cooling, or treatment directly opposite that followed with carbon steel.

NEW BATH UNIVERSAL GRINDING MACHINE.

A universal, combination grinding machine, having many ingenious features, has been brought out by the Bath Grinder Co., Fitchburg, Mass. This machine is the invention of Mr. John Bath, who for many years has devoted his time to the development of grinding machinery, and was the inventor

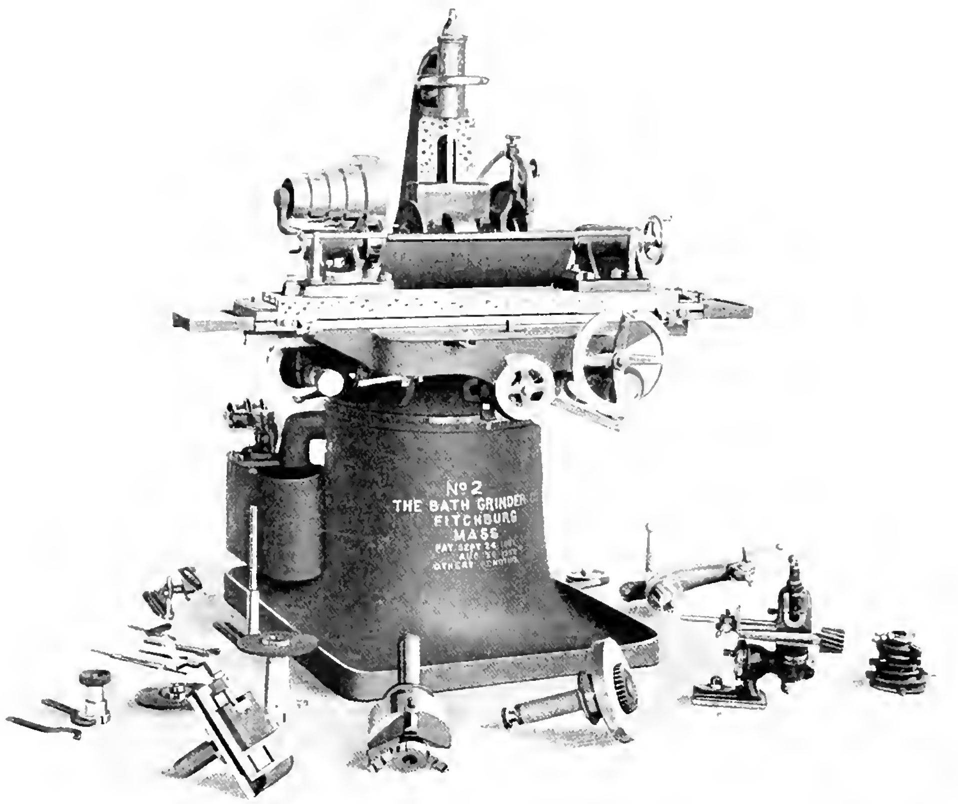


Fig. 1 Bath Grinder. Front View, showing Fixtures.

of the Bath universal combination grinder described in MACHINERY for October, 1902. The new machine, while retaining some of the features of the older one, is in other respects entirely different and embodies many improvements. It is now built in two sizes and other sizes are to follow.

Among the features to which attention is called are, the design of the frame and table slide, by which the table may be swiveled about the vertical axis into any desired position relative to the wheel; a vertical grinding-head slide, by which the wheel may be made to pass vertically over the surface of the work for certain operations, instead of horizontally; a combination holder by means of which cutters and many other pieces of work to be ground may be held at any angle; and grinding wheels formed with faces of several diameters, which permit a variety of work to be performed without changing wheels.

The front view of the machine, surrounded by its fixtures, is given in Fig. 1. It has a large circular base, on the top of which is a projecting flange. Upon this base flange is another flange, concentric with it, which forms the bottom portion of the column used to support the grinding head. This column has vertical ways, on which the grinding head travels. Upon the graduated flange forming the base of the column is pivoted a swiveling bottom slide which carries the cross and longitudinal slides that support the work table.

In Fig. 2 is a back view of the grinder which clearly shows the pivoting slide that supports the table and that may be swung through any angle and clamped by the handles appearing at the base of the upper flange. This slide is made with long ways, so that even when the table is in its outermost position it will not overhang, but will still have the solid support of the slide and the base of the machine. Water from the wheel passes through a wide opening in the center of the slide into a puddle pan at the bottom of the inside of the base and is pumped back to the wheel by a centrifugal pump through the hose, as shown. The spindle-driving pulley and cone pulley are in one casting which runs on a stationary shaft. The face of the spindle-driving pulley is 5/8 inch wider than the belt, and therefore keeps the two belts apart. The cone is supported by a frame pivoted on the back of the machine and arranged, by means of a compression spring, to automatically maintain the same tension of belt at any position of the grinding head. An independent tightener is also provided, to take up the slack of the belt as it stretches.

The table has automatic longitudinal and cross feeds (the latter is automatic in the larger size only), and is fitted with the usual swivel plate the same as any universal grinder. This swivel plate has two slots for clamping purposes, and one V-groove on the front for guiding the head- and footstocks, which have one V and one flat bearing.

The machine is adapted for all classes of cylindrical and conical grinding within its scope. A special fixture, shown in Fig. 8, is used for internal grinding, the spindle being driven by a belt from a pulley on the end of the grinding wheel spindle. For surface grinding either the cross feed of the table may be employed or the table may be swung around so as to travel parallel with the plane of the wheel, in which case the longitudinal feed is used. It will be evident that, by means of this swivel slide, an unusual range and variety of movement is possible.

For cutter grinding and for various other kinds of grinding, especially upon small pieces, the movement of the table is made use of chiefly for placing the work convenient to the grinding wheel, the relative movement between the wheel and the work

Fig. 2. Rear View of Bath Grinder.

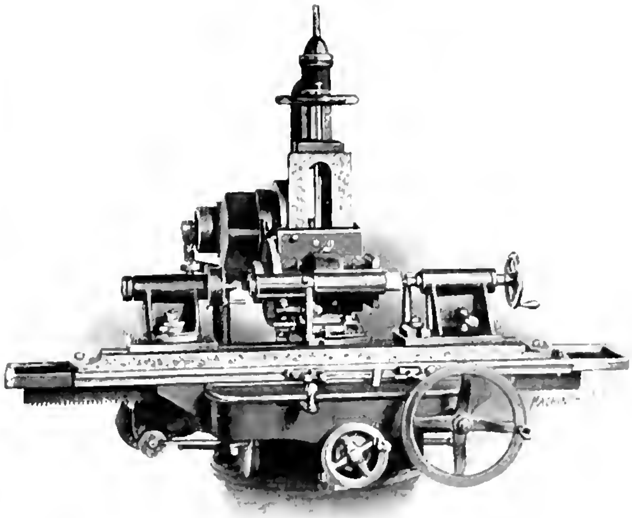


Fig. 3. Reamer Grinding. Method of Clearance Measurement

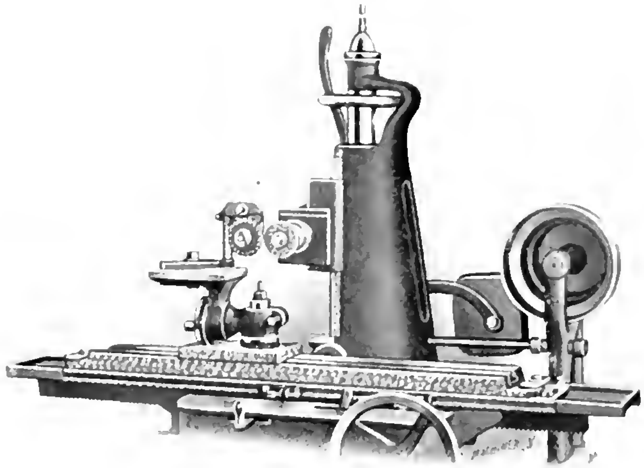


Fig. 4 Cutter Grinding, with Universal Holder and Tooth Rest Stand

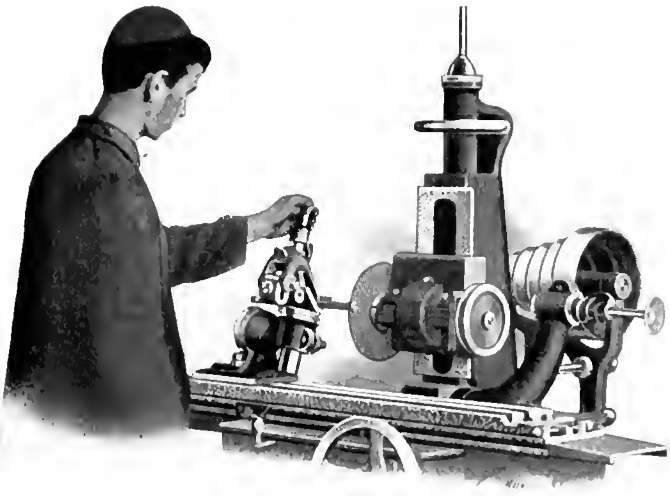


Fig. 5. Cutting off Hardened Tap by Hand.

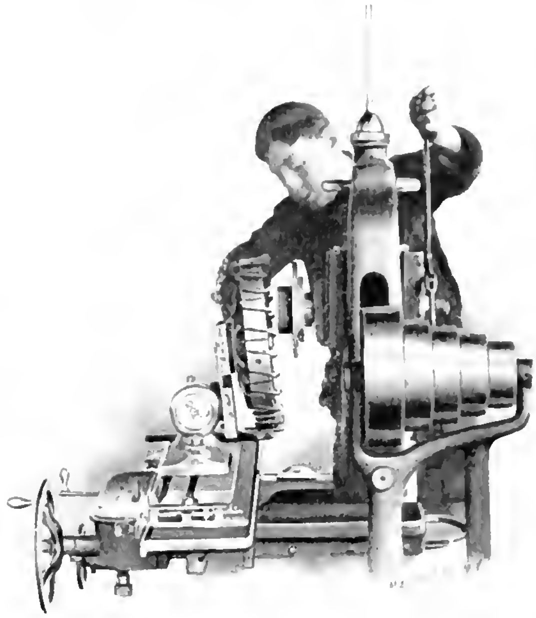


Fig 6 Grinding an Inserted Tooth Face Milling Cutter

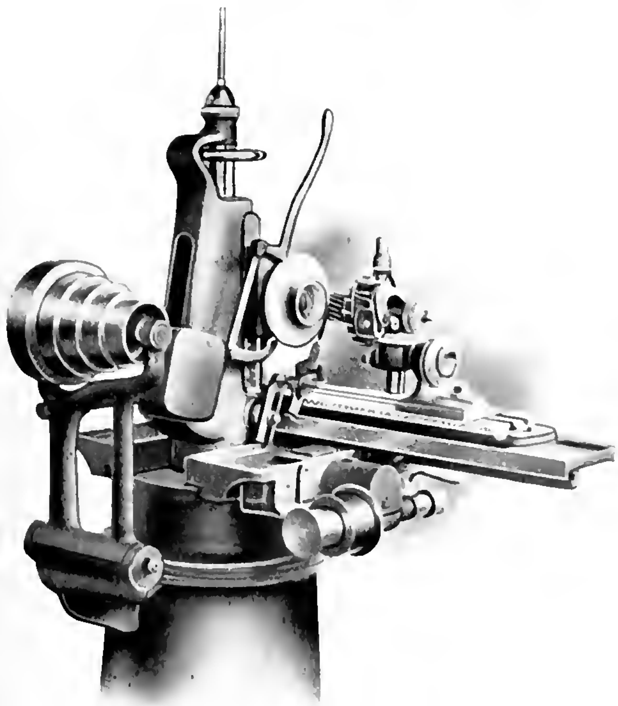


Fig. 7. Illustrating the Advantage of the Two-faced Grinding Wheel

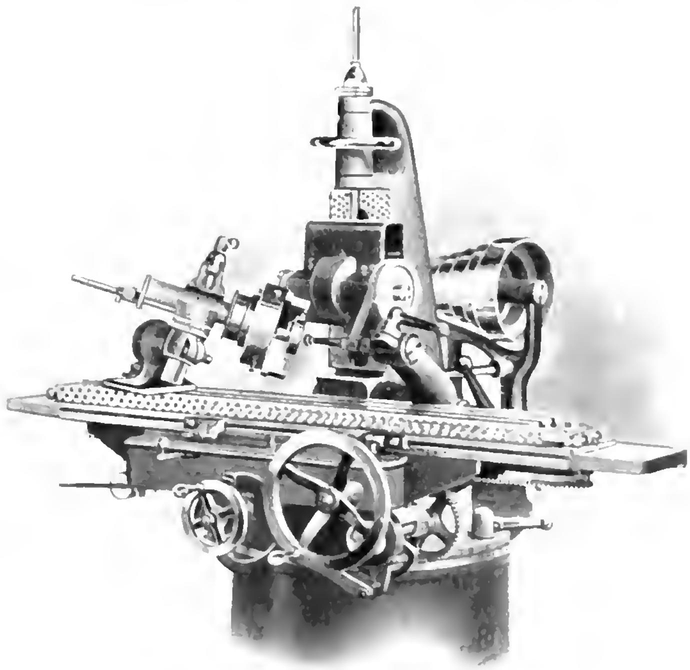


Fig. 8 Using the Internal Grinding Attachment

being obtained, not by the travel of the work past the wheel in a horizontal plane, but by the vertical movement of the latter past the work, which is held stationary. In such cases a universal holder is employed, which is shown in several of the illustrations, and constitutes one of the distinguishing features of the machine. This holder has both horizontal and

vertical swivels with graduated movements. It is furnished with a V-vise and a horizontal vise which mounts on a flange plate. There is a T-slot in the bottom of the horizontal vise which permits the vise to be swiveled or adjusted on the flange plate, and clamped by a square-headed bolt, which passes through the stem of the flange plate into the T-slot in the vise, and is clamped underneath by a nut. The V-vise and flange plate stems both interchange to the same socket of holder, and in some operations they are used together or independently. If used together, the stem of the flange plate may be held in the V-vise.

Many styles of cutters can be ground by mounting on a plug screwed into the surface of the upper flange plate, and in such cases a plunger tooth rest is employed. This consists of a small pin inserted in a hole in the face of the flange, which is forced above the surface a short distance by a spring. The teeth bear against this pin in succession, and when the cutter is rotated each tooth depresses the pin, which springs back after the tooth has passed, forming a rest for that tooth.

Upon the front side of the upright frame is mounted the spindle head, which has a vertical movement. The position of the head is given by a graduated sliding bar, seen projecting at the top of the column. The graduations on this bar, together with those on a dial revolved by the handwheel which raises and lowers the spindle head, enable adjustments to be made within .001 inch. By this system clearances are obtained for all kinds of cutter and reamer grinding, and locations for various other operations. The spindle head may derive its vertical movement either from a screw or lever, as shown in Fig. 7. In one of the two sizes of the new grinder, the slide is counterbalanced for this movement, giving a quick, sensitive lever movement by hand. An adjustable gage stop, for gaging the length of stroke, is also provided in this machine. A great advantage claimed for the vertical slide is that it is about two-thirds shorter on the same length of tooth than the horizontal slide movement. Much less power also is required to move the counterbalanced vertical head than to move the table horizontally. The screw movement may be changed readily to the lever movement by the removal of a screw which connects the vertical head to the lifting screw. The hand lever is removed for cylindrical grinding on centers.

Fig. 3 shows the method of clearance measurement for reamer and cutter grinding used with this machine. In the illustration a 2½-inch reamer is being ground by the 8-inch disk face of the two-faced grinding wheel. When the spindle head is raised above or lowered below the center line to give clearance, an exact reading is obtained by means of the sliding bar graduated in sixteenths of an inch and the revolving dial which gives a reading of 0.001 movement. In this case a reading is obtained of ⅛ on the bar and 0.010 on the dial, which shows that the spindle was raised ⅛ and 0.010, the proper clearance when the reamer and wheel are of the given diameters.

In Fig. 7 the spiral tooth of an end mill is being ground by the disk face of the wheel, using the spring tooth rest. The end of the same end mill had previously been ground with the cup face of the emery wheel, and a plunger tooth rest. In this operation the mill is held in the holder by a taper bored sleeve which can be adjusted to the holder without any end play, and is revolved in the V-vise of the holder. A gage stop is not required for the end of the shank to abut against in grinding. The advantage of using the universal holder and the grinding wheel of two diameters is seen in that the cutter did not have to be removed from the holder or the position of the machine changed in passing from one to the other of the two operations just enumerated.

Fig. 4 shows the grinding of a convex cutter with the regular universal holder and the tooth rest stand. For this operation the holder is placed on the stem of the flange plate, bottom side upward. The tooth rest stand is then clamped to the bottom side of the holder, with the cutter placed in position for its radius to be ground, directly over the pivot point of the holder. For feeding and placing the cutter to the wheel the cross and longitudinal fine feed are used.

In Fig. 6 is shown a 14-inch inserted tooth face milling cutter of 24 teeth, which was ground in 55 seconds. As represented, the cutter is mounted on a stud screwed into the flange plate of the holder, and held in position by a nut and washer. As the cutter is mounted on the long end of the flange plate it can be raised or lowered by the pivotal swinging of the plate. The plunger tooth rest is used on the tooth being ground. The wheel is drawn vertically against the cutting edge of the tooth.

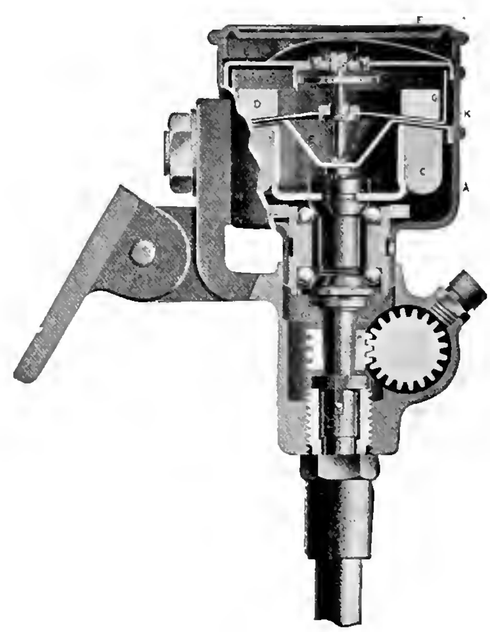
In Fig. 5 a hardened tap is represented being cut off by hand. The vertical pivot of the holder is clamped immovably, and the horizontal pivot is loosened, thus allowing the top portion of the holder to swing backward and forward.

In Fig. 8 the back side of an inserted tooth shaping tool is shown being ground. This figure also shows the internal grinding fixture in place. Many other difficult and interesting jobs of grinding may be performed by the Bath grinder besides those just described.

* * *

THE WARNER AUTO-METER.

The development of the automobile has made imperative some reliable instrument which shall indicate in direct reading at any moment the speed at which the machine is traveling. The Warner Instrument Co., Beloit, Wis., have designed a combined speed indicator and speed recorder, a sectional view of which is shown in the accompanying cut. The indicator is built on the principle of their well-known meter, used in machine shops for indicating cutting speeds of lathe and planer work, etc. A gear is mounted on the hub of the front wheel, which drives a pinion connected to a flexible shaft which leads to the instrument mounted in front of the operator where the readings can be easily seen. The flexible shaft drives the magnet, *C*, which revolves freely upon ball bearings. This magnet is not in any way connected with the indicating dial, save by the lines of magnetic force. The hair-spring, *H*,



Section of Warner Auto-meter.

holds the dial to the zero point, but the magnet when revolving has a tendency to draw the dial in the direction of its rotation. The hair-spring opposes this tendency, but the greater the rapidity of the magnet's rotations, the greater is the displacement of the dial. For instance, when the speed of the magnet doubles, the displacement is doubled, hence the dial is evenly graduated throughout its circumference, which is nearly 6 inches. This length gives ample space between the graduations, making them and the figure indicating "miles per hour" very legible. The worm and worm gear shown in the sectional view are for operating the odometer, the device for registering the number of miles traversed. These instruments are sent to the users carefully calibrated, and sealed so as to be absolutely dust-proof. An interesting feature is that internal parts are gold plated; this is not done for appearance sake, but to prevent corrosion.

LIFTING MAGNETS FOR HANDLING IRON AND STEEL.

We have received from the Electric Controller & Supply Co., Cleveland, O., the accompanying photographs showing some of the uses to which electric lifting magnets can be profitably put in plants where large quantities of iron and steel material are handled. The use of magnets for this purpose, while not new, is still so little known in the great majority of shops that it possesses the feature of novelty for most of our readers. It is claimed that wherever iron or steel is handled in quantities by means of cranes, an electromagnet should effect economies in time and labor sufficient to pay for itself in from one to six months. This is borne out by the experience of the Illinois Steel Co., who use fourteen magnets in their South Chicago shops alone, where they have found the economy in time and labor so marked that they have decided to use them wherever possible throughout their works. These magnets have been found particularly useful in steel mills, jobbing houses, safe works, foundries, and other places where iron or steel pieces have to be handled in large quantities, in which cases the labor cost of attendance is a considerable item.

The magnet is suspended from the hook of the crane, a direct current of any common voltage being employed to energize it, transmitted through a flexible twin conductor cable; a small switch operated by the crane attendant is usually the only additional apparatus necessary. The consumption of current is small, being from one to twelve amperes, according to the service for which the magnet is designed. In this connection it may be mentioned that a single design of magnet is not adapted to handling the full range of material, such as pig iron, scrap, rivets, bolts, ingots, blooms, slabs, billets, bars, plates, rolls, structural shapes, pipe, etc., but on the contrary the magnets may be designed to meet the form of material to be handled. There is a wide difference, for instance, in the design of a magnet for lifting ingots or blooms, and one adapted to the handling of thin plates. A magnet which would handle five tons in the form of an ingot might not safely handle 500 pounds in the form of thin plates. It is therefore necessary to know in each case the operating conditions to which these devices are to be applied in order to insure an economical and safe design. An advantage of considerable importance in many places is the reduction of head room necessary when using the ordinary hook and chain. With the lifting magnets this reduction is considerable, especially on material of considerable width, such as plates. This enables piles of plates to be carried higher in storerooms than is possible with the chain, and another advantage is that no space around the piles is necessary for the men superintending the piling, as is the case when using chains. This has been found to be a very important consideration in storage yards of steel mills, where the alleys left between the piles of material absorb a considerable percentage of the total available space.

In the handling of material the magnet is lowered upon it and the switch closed, thus causing it to attract and hold it firmly while being hoisted by the crane and transported to the desired point. Simply opening the switch instantly releases it. The natural objection of those unfamiliar with the operation of lifting magnets is the apparent risk of accident. The Electric Controller & Supply Co. inform us that in their experience with scores of lifting magnets in successful operation, they have yet to learn of a single accident which has occurred through their use, while on the other hand accidents due to the slipping or breaking of hooks and chains are known to be of frequent occurrence. The magnets made by this concern are tested with a load from four to five times as heavy as that specified, which should give an ample factor of safety.

The magnet shown in Figs. 1, 2 and 3 is 35 inches in diameter and costs for current about 6 cents per hour to operate continuously, this figure being based on a cost of 3 cents per kilowatt for current, and on the supposition that the current will be on the magnet for 60 per cent of the time. Fig. 1 shows the magnet lifting three kegs of cotters, with the heads on the kegs. Fig. 2 shows the same magnet lifting the contents of the kegs in the shape of loose cotters, the magnet gathering up nearly every cotter contained in the three kegs. In Fig. 1 several nails will be noticed standing out. These were thrown on the keg by some of the spectators and stayed there standing straight out, showing that the whole mass was highly magnetized; but when released the cotters immediately and entirely lost their magnetism, and the same applies to all soft steel or iron. In Fig. 3 the magnet is shown lifting twelve pigs of pig-iron, each weighing approximately 75 pounds. These were lifted from a pile upon the floor.

The design of this type of magnet is the result of a series of experiments to obtain the most efficient design for the handling of iron and steel objects of irregular shapes in blocks. The lower end of the center pole is not in the same plane or level as the outer pole, but when the magnet is set down on the floor, for illustration, the center pole does not touch it within $2\frac{1}{2}$ or 3 inches. In this way an intense mag-

Fig. 1. Magnet Lifting three Kegs of Cotters; Heads on Kegs.

Fig. 2. Magnet Lifting Contents of three Kegs, in Loose Form.

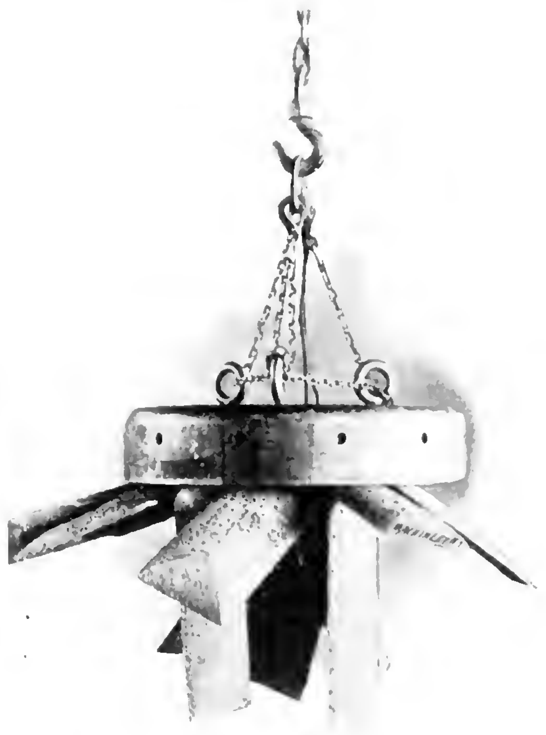


Fig. 3. Magnet Lifting twelve Pigs of Pig Iron Weighing 900 pounds.

netic field is obtained which concentrates the load around the center pole. The lifting magnet, shown in Figs. 1, 2 and 3, weighs from 1,500 to 1,700 pounds equipped complete with chains for attaching it to the crane.

* * *

THE USE OF DISTINCTIVE COLORS.

OSCAR E. PERRIGO.

There are some things which appeal to the sense of sight much more readily than to any other faculty, and seem to force themselves upon our understanding whether we pay much attention to them or not. Not only this, but they produce a lasting impression that is not easily gotten rid of. Notable among these is the perception of *colors*.

If we undertake to direct a friend to a certain house, we may remember that it is between two certain streets, or that it is just beyond a certain street, but the idea we are most likely to be sure of is that it is a red house, or a brown house,

Fig. 4. Magnet Lifting Blooms; weight, 1700 pounds.

or a yellow house, etc., for we can nearly always remember the *color*. The collector calls to collect a bill. The busy man at the desk glances at the accumulation of them in a clip and impatiently says: "I am very busy to-day and can't stop to look for your bill just now; call again." But the collector says: "You don't have to look much, it is that red one there." The red bill is withdrawn and the matter quickly adjusted. It was the *color* that did the business. And so it goes on, and many persons who will run over a lot of different blanks, all of one color, without finding the right one for some time, will readily select the right one if it is printed on a paper of distinctive color. Such being the case with a very large majority of persons, we may profitably make use of this peculiarity in formulating and practicing some of the necessary systems for organizing the daily routine of clerical and mechanical work in the office and shop.

First, let us consider the use of distinctive colors for office or shop blanks. In the column below, the first nine are the preferred colors. If these are not sufficient for the number of blanks wanted, those following may be resorted to. There are other shades which the printer can show us, but the idea is to get ordinary and well-known colors, as well as those of as much difference in color as possible.

White.	Yellow.	Dark Green.
Manila.	Pink.	Orange.
Light Red.	Drab.	Rose.
Light Blue.	Lavender.	Gray.
Light Green.	Dark Red.	Chocolate.
	Dark Blue.	

This gives us, as will be seen, nine light colors, which are preferred because the printed matter shows up plainly on these colors of paper, and seven less desirable, but perfectly practical tints, if the number of blanks requires them. The less desirable tints may also be used for blanks that are seldom needed. Where the blanks are used in several departments the colors in local use should be as dissimilar as possible, while a similar assortment of colors may be used for local blanks in the other departments.

The men through whose hands these blanks pass will soon become accustomed to their distinctive colors and speak of them, not by their printed headings, but as "a red blank" or "a blue ticket," etc., and their color will almost invariably secure their use for the purpose intended, much more certainly than any amount of printing on their face. In sorting out the mass of blanks as they come into the office of the superintendent, the timekeeper, or the foreman, the work can be done in about one-fourth of the time that is required when all the blanks are of one color.

Again, distinctive colors can be used for patterns, by which core prints are distinguished from the parts of the pattern to come out in metal, as well as to indicate the kind of metal of which the castings are to be made. The system is as follows: All core prints are red; all patterns for the gray iron foundry are black; those for the malleable iron foundry are brown; those for steel castings are blue; for brass castings yellow, and for bronze castings orange.

In the shop where this system was put in practice the patterns and core prints had formerly been made of any color to suit the fancy of the particular patternmaker who made them, black, of course, predominating. The unpleasant as well as expensive result was that patterns for gray iron castings were liable to go to the malleable iron foundry, and *vice versa*, or patterns for the malleable iron foundry would go to the steel foundry, and a great many mistakes were made. With the advent of distinctive colors came such a change that in thirteen years of practice not a single pattern went to the wrong foundry, so far as was known.

In the pattern loft the different colors may be made use of by painting the stripes in front of the shelves of different colors to distinguish the various machines to which the patterns belong, afterward lettering them for the different sizes or types. For instance, in a shop building machine tools, we may use the colors as follows: Blue for lathe patterns; white for planer patterns; green for drill patterns; yellow for milling machine patterns; light red for slotter patterns, and dark red for shaper patterns, and so on as may seem most convenient

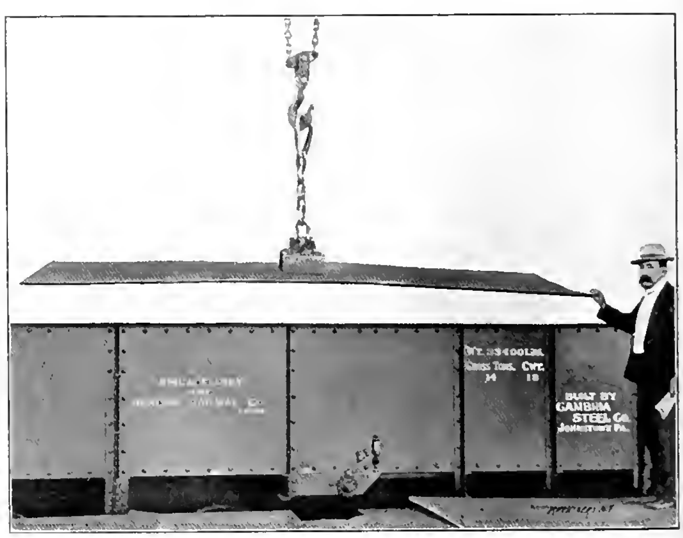


Fig. 5. Handling Steel Plates.

or appropriate. An inexperienced boy or man, or one not acquainted with the location of the patterns may be sent to the pattern loft after a pattern, and by giving him the color of the shelves where the particular group of patterns may be found much time will be saved, even though the different series of shelves may be numbered and lettered.

In making the colors herein mentioned the following *dry* colors are mixed with shellac varnish, namely: Lamp black, vermillion, Prussian blue, burnt umber and chrome yellow. The Prussian blue is made lighter by adding a little *dry* white lead. The orange is made by adding a little red to the chrome yellow. If we desire to use green it may be made with *dry* chrome green, light or medium shade.

In mixing two colors together they should first be dissolved separately in shellac varnish, and then mixed when in a liquid state.

NINETY-SIX INCH SELLERS PLANER WITH AIR-OPERATED FRICTION CLUTCHES.

The new planer by Wm. Sellers & Co., Inc., Philadelphia Pa., shown in Fig. 1, is the one alluded to editorially in MACHINERY for last June. While an exhibition of this interesting machine tool was given before a number of engineers on April 30 last, the description of it has just been given out for publication.

The planer is intended for work not exceeding 96 inches wide, 96 inches high and 20 feet long. It is equipped with two cutting tools on the cross rail and one on each of the housings. Each of the two saddles has its own feed motion, independently adjustable in direction and amount. Each has also its own stopping and starting device, but the planer is so arranged that all of these can be thrown out of action or into action simultaneously by the motion of a hand lever, manipulated from either side of the machine. The table has a constant return speed of 80 feet a minute, and a variable cutting speed of from 15 feet to 45 feet a minute. The table is supported in one flat and one V-bearing, which are provided with a forced system of lubrication by means of a pump with circulating pipe system, oil tank and filters. The V-bearing has four surfaces, two forming a V of large angle, sufficiently inclined to guide the table under ordinary circumstances, but

tion clutch. The wheel *G* is turned on both sides in a similar manner. *J* and *M* are two conical male elements fastened together and forming an air-tight cylinder free to move back and forth on the disk *H*, which is keyed and pinned to the shaft *K* and forms a piston in the cylinder. In order to compel the shaft to rotate with the friction clutch the head of the cylinder *J* is provided with notches into which project teeth on the surface of the piston *H*, as shown in the view above *H*, in Fig. 2. These form a jaw clutch and permit end movement, while they compel the parts to rotate together. Air admitted to one end of the cylinder through the center of the shaft *K*, between the parts *H* and *M*, for example, will cause the cylinder to move in the direction of the pulley *A* and to press the friction cone against the pulley so as to cause the clutch to rotate with the pulley. This movement will be transmitted through the piston *H* by the clutch teeth and cause the shaft to rotate in the same direction, which produces a return movement of the table. Admitting air to the opposite end of the shaft will cause the clutch *J* to engage with the wheel *G* and to force the latter against the stationary clutch *L*, which is keyed to the shaft. The wheel *G* will then drive the shaft through both of the clutches, one on either side, in the proper direction for cutting at a speed

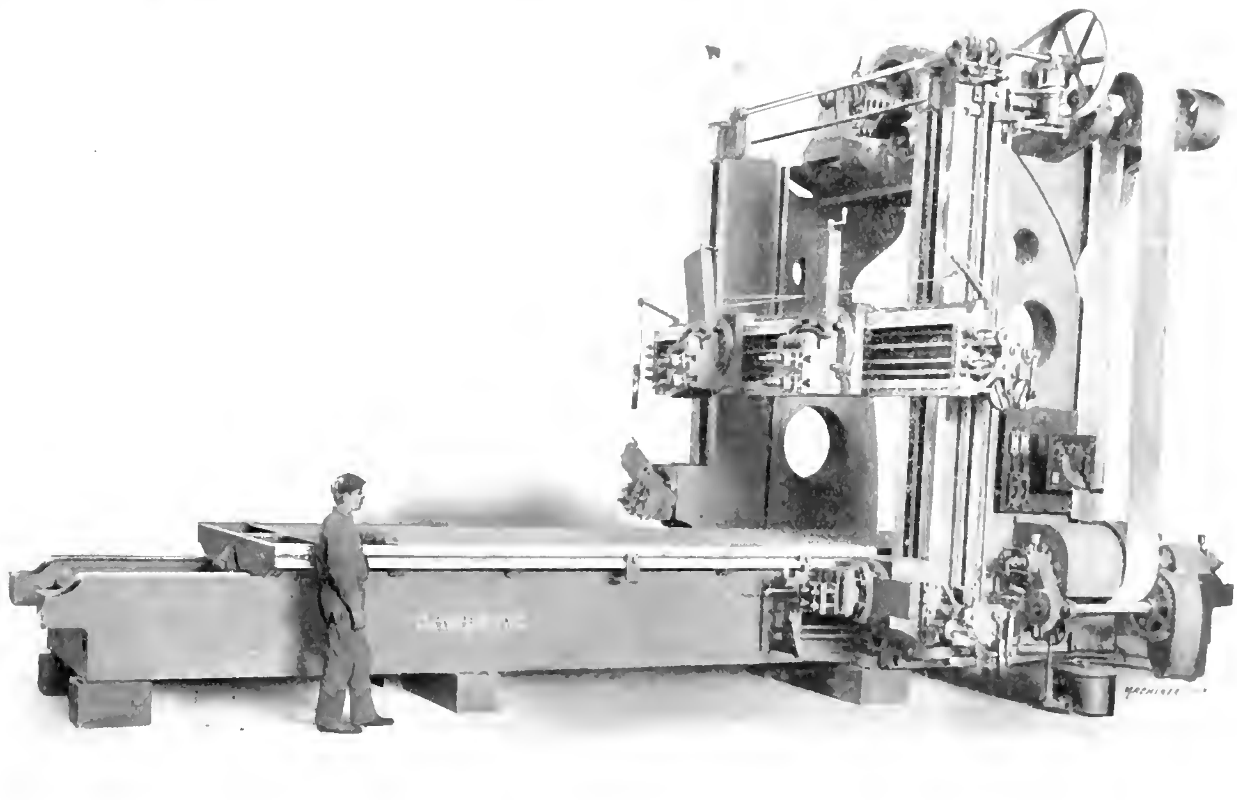


Fig. 1 Sellers Planer, with Air-operated Clutches

having the minimum wedging action. The other two surfaces are nearly vertical. These do not bear under ordinary circumstances, but are ready to resist side cuts which are sufficiently heavy to slide the table up on the V, so as to bring the vertical surfaces in contact. This arrangement permits the table to run lightly under ordinary work, but prevents it from lifting under any condition of heavy side cutting. The table rack of 2¾-inch pitch and 10-inch face is driven by a spiral pinion of 5 threads.

The driving and reversing mechanism is shown diagrammatically in Fig. 2. *P* represents the shaft which carries the spiral pinion driving the table. On its outer end is mounted a spur wheel, *O*, driven by the spiral pinion *N* on the pulley shaft. The driving pulley *A*, which is loose on the pulley shaft *K*, runs continuously and in the same direction while the planer is in operation. On the hub of the pulley *A* is a pinion *B* driven through a reducing train of wheels, *C*, *D*, *E* and *F*, to a loose wheel *G* mounted likewise on the pulley shaft. It is evident that the wheel *G* will run in the opposite direction to the pulley *A*, and at a reduced speed depending upon the ratio of the gears in the train. The pulley *A* is turned on one side to form the female half of a conical fric-

which may be varied by changing the gears *E* and *D*. These are mounted on split bushings with conical holes, which permit the gears to be shifted with the minimum amount of trouble.

In the operation of the planer the table stops move an air valve which admits compressed air alternately to the opposite ends of the cylinder, and by regulating the velocity of the admission the speed of reverse can be nicely gaged. It is arranged so that the table is brought to rest promptly and started up in the opposite direction without shock. There is no reversal of high-speed pulleys and the flywheel action of the parts whose motion is reversed, owing to their relatively small size, is greatly reduced. The pulley *A* may be driven through a countershaft in the ordinary manner or from a motor as in the present instance, where the 50 H. P. motor is mounted on a cast iron platform carried on brackets from the housings, the platform serving as a cross girt between the housings. The motor drives by horizontal belt to a countershaft, which in turn drives the pulley shaft at the base of the housing.

A separate belt is used to actuate the lifting gear and drive the feed motion. The latter is accomplished through a posi-

tive motion clutch, which is stopped and started at each reversal of the table. The movement of the table dogs not only actuates the air valve, but it trips the escapement train in the feed motion, and allows it to make half a revolution. This gives a half turn to each of the crank disks, transmitted from the clutch through a square shaft on the side of the housing, by bevels to a horizontal shaft driving a similar square shaft on the left-hand housing. Each of these disks having a half turn at each reverse, the amount of feed is determined by the position of the crank. The work done by the dogs, it will be seen, is of the lightest character, and the shifting by hand is also easily accomplished.

A novel feature of the side heads is that they are lifted by the same screws which carry the cross rail. These screws are stationary under ordinary circumstances, and the heads are raised and lowered by rotating the nuts. It is found in practice that this form of clutch releases and engages with great regularity and very promptly, so that the stroke of the planer is remarkably uniform, the reverse always taking place at the same point. The overrun at the beginning of the stroke is only sufficient to allow the feed to act.

laws relating to trade-marks. The four items that appeal most to manufacturers are: Reduction of the registration fee from $25 to $10; the unrestricted registration of all marks that have been in use ten years; the extension of registration to marks used in interstate commerce only, and the appeal to the Court of Appeals in cases that are rejected by the Commissioner. From a report of this bill by Mr. Bonynge, of the Committee of Patents, we quote the following:

"In the past there has been considerable complaint in regard to what could be registered under the existing law as a trade-mark. Much of the time of the committee in the hearing of the bill has been consumed in a discussion upon this particular feature of the legislation. The proposed bill will permit the registration of all marks which could, under the common law as expounded by the courts, be the subject of a trade-mark and become the exclusive property of the party using the same as his trade-mark, and a proviso has been added permitting all marks that have been in actual use as trade-marks for a period of ten years to be registered.

When the application for registration is filed, the bill provides for an examination of the mark offered. If upon such

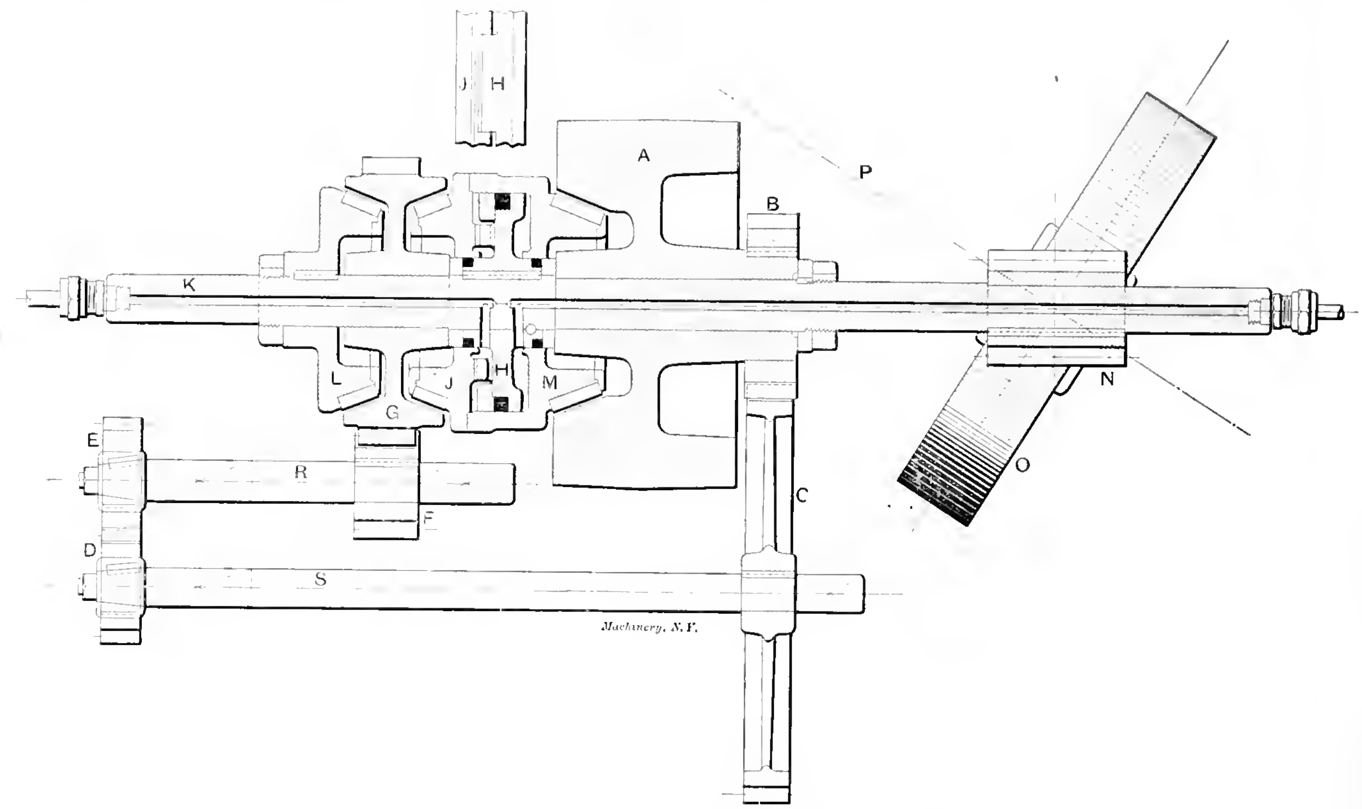


Fig. 2. Sectional View, showing Drive and Reversing Mechanism.

Another novel feature about this planer is the manner in which the cross rail is secured to the uprights. The back of the cross rail between the uprights is extended in a rectangular form, with two vertical surfaces fitted with gibs to the inside surfaces of the uprights or housings. A flange on the back of the cross rail extension is provided with bolts working in T-slots in the inner faces of the uprights. Tightening these bolts draws the uprights against the crossrail, which is also secured to the face of the uprights in the ordinary manner. This method of bolting brings into play the strength of the housing to resist the torsion of the cross rail, and at the same time the cross rail stiffens the housing against the twisting action of the side heads. The effect is an enormous increase in the strength of the combined parts, so that unusually heavy cuts can be carried.

In some 54-inch planers of this construction, two cuts of 60,000 pounds each were taken in steel, without any perceptible spring of the cross rail, although the latter was scarcely larger than what is usually provided for a planer of that width.

The total weight of the planer is about 60 tons.

* * *

NEW TRADE MARK BILL.

A new bill has been introduced in the House of Representatives, with regard to the revision and modification of the

examination the application is refused, notice is given to the applicant in order that he may appeal, if he so desires, from the decision. If, on the other hand, the examination discloses that the mark is entitled to registration, the act provides that the Commissioner shall cause it to be published at least once in the Official Gazette of the Patent Office. The purpose of this publication is apparent. Owners of trade-marks ought not to have their rights to the use of a trade-mark jeopardized by the registration of similar trade-marks by other parties not entitled to the use of the same. The right to the use of a trade-mark is perpetual, so long as the same is actually used in commerce.

By another section of the bill provision is made for designating registered trade-marks by printing under the trade-mark the fact that it is registered, as is done in the cases of patents, so that any person who imitates or counterfeits a trade mark will not do so in ignorance.

* * *

The underground railway system of London is operated only in part by electricity, steam engines still being employed in a number of the tubes. When the electrification of all the subways is completed, as planned, one will be able to travel sixty miles underground without running over the same piece of track.

BULLARD THIRTY-SIX INCH VERTICAL TURRET LATHE.

The new vertical boring and turning mill brought out by the Bullard Machine Tool Co., Bridgeport, Conn., or as it is styled by the makers, the vertical turret lathe, is the result of considerable experimenting on their part. It is especially designed for the handling of heavy faceplate work, which, with a horizontal faceplate lathe, would require considerable time in chucking. The vertical construction has, besides the gain of time in setting, various other points of superiority for such work over the horizontal lathe, and the present patented design is intended to take the fullest advantage of these natural superiorities, and also as far as possible to embody in the vertical mill points which usually are seen only in horizontal lathes. As shown in the front view, Fig. 1, the lathe has a five-sided turret on a turret slide, and also a side head which bas vertical and cross power feed, and which is so arranged as to interfere in no way with the turret when both heads are being operated jointly on work of either large or small diameter. A use of any loose gibs. The holes in the five faces of the turret are 2½ inches in diameter, the inscribed circle to which the faces of the turret are tangent being 10 inches in diameter. The turret faces are square with the table, and tapped holes are provided for attaching special tool holders. The vertical and side heads are entirely independent in their movement, both as to direction and amount of feed. The vertical head will face 36 inches, and has a vertical and angular movement of 26 inches. The turret is of such a construction that either single-point tools or simple formed tools may be used to advantage. Binder plugs are provided in the turret, having a double grip on the tool holder shank.

The side head has a vertical movement of 28 inches, and a horizontal and angular movement of 15 inches. It may be set to an angle of 40 degrees either side of the horizontal. It carries a four-faced turret tool holder, thus obviating the necessity of frequent change of tools. In this, 1-inch by 1¾-inch tool steel may be used. Long boring bars and extended tool holders are not required in the vertical turret, when the side head is

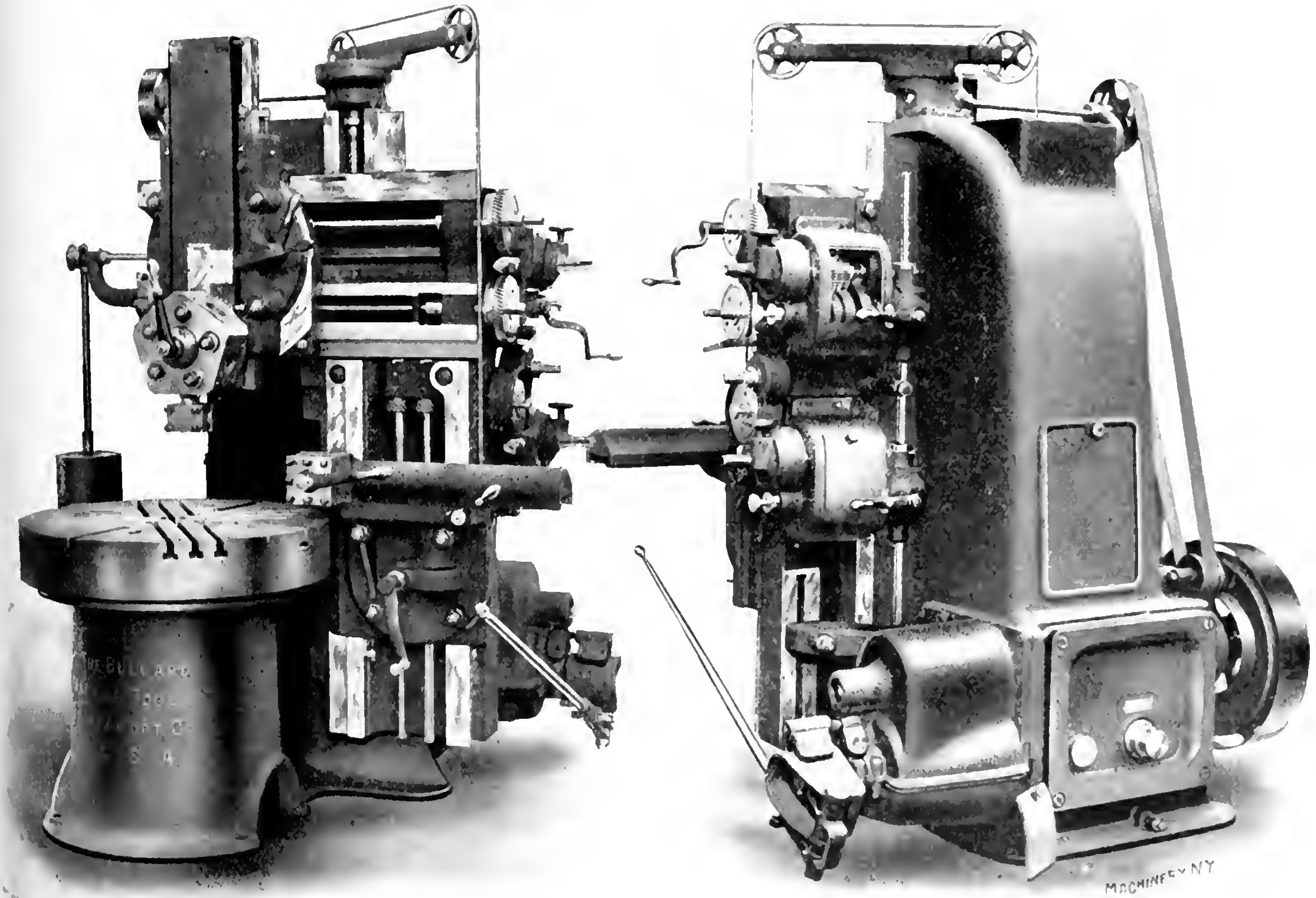


Fig. 1. A New Bullard Boring and Turning Mill which the Manufacturers style a "Vertical Turret Lathe"

mill with these features is very similar to a regulation horizontal turret lathe, as may be seen by inspection of Fig. 3, which represents the machine turned over on its back.

The lathe has a capacity of 36 inches in diameter and 24 inches in height. The table is 34 inches diameter and is driven by an internal spur gear having a diameter nearly that of the table. The latter is carried by a spindle having a self-centering tendency, due to a large angular thrust bearing, side strains being taken by vertical bearings of large proportions. The weight of the table and spindle, as well as the weight of the work upon the table, tend to preserve rather than destroy alignment, in which is evident a point of superiority over the horizontal faceplate lathe with its heavy overhanging piece of work.

The turret head has both cross and vertical feeds, and may be swiveled to 45 degrees either side of the center for taper boring and turning. The slide is square locked throughout, all adjustments for wear being made by taper wedges without the used. The latter possesses not only the points of vantage of the carriage of the horizontal machine, as the cross and vertical feeds, but by its swiveling, angular facing through a wide range may be done. The machine may be supplied without side head if desired, in which form it has a capacity of 41 inches in diameter.

The arrangement of the feed and speed gears is seen from the back view of the machine given in Fig. 2. Fifteen changes of table speeds, ranging in geometrical progression, are mechanically obtained from a single speed driving pulley through a speed box containing powerful self-adjusting friction clutches. Change to any speed desired is obtained by a lever conveniently placed at the front of the tool. By lifting this same lever the table is stopped at any desired point by means of a direct-acting brake which operates at points intermediate between speeds, without stopping the driving pulley.

The feeds for both heads are positive, and have eight changes ranging from 1-96 to ½ inch in all directions. Feed changes

for either head are obtained by turning a star-wheel, the amount per revolution being indicated on a direct-reading index plate on each feed box; change from vertical to cross feed or *vice versa* is obtained by engaging a centrally located drop worm with the worm gears on the ends of the feed rods, thus eliminating the pull gears often seen on feed rods. Safety points have been so arranged in the feeds that carelessly permitting the heads to run together results in no damage to the feed works. This device is said to in no way weaken the feeds; it is not in use when the threading attachment is engaged. The lubricating system is very complete. The headstock speed

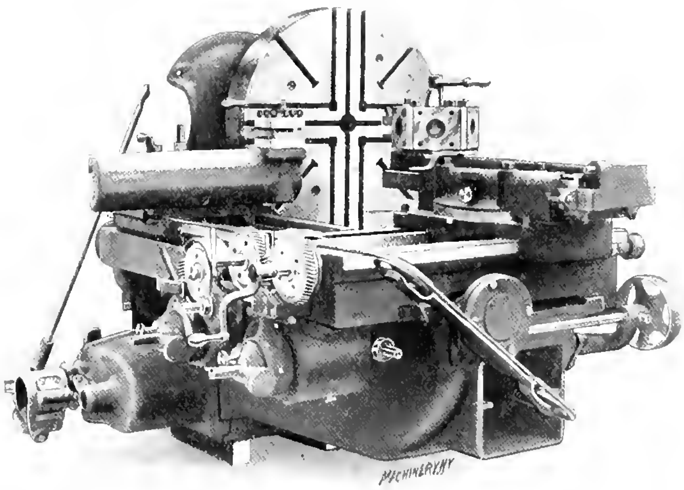


Fig. 2. Bullard Vertical Lathe on its Back, showing resemblance to Horizontal Lathe.

box and the feed boxes are entirely encased, and the gearing runs in a constant bath of oil. All high-speed journals run in bronze bearings and are self-oiling. The table spindle is constantly immersed in oil, and sight feed lubricating cups are so placed that the oil level may be maintained.

The cross and side rails in this machine are a unit, and have a vertical adjustment by power of 12 inches. A much greater efficiency for the vertical slide is thus available on work of various lengths. The side rail may, of course, be removed if it is desired to use the machine without the side head. The guide bearings for saddles are narrow, the ratio of length to width being great to prevent tilting and binding of the heads.

The driving pulley is 24 inches in diameter for a 4-inch double belt. The countershaft has one tight and one loose pulley, 14 inches in diameter for a 4½-inch belt, and should run 420 R. P. M. A 7½-H. P. constant speed motor may be mounted on a bracket at the side or rear of the machine, and connected up by a belt, gearing, or chain. If used, its speed should not exceed 1,200 R. P. M. A thread-cutting attachment may be used on the vertical head if desired. The machine is self-contained, and is very rigid, box sections being used. It is an efficient machine for the use of the new tool steels.

* * *

REINFORCED CONCRETE PILES.

Recently 580 reinforced concrete piles were driven, in making the foundations of the new railway station at Hamburg. The soil on which the station is built varies considerably, but is composed chiefly of sand, marl, and clay, and it carries a great deal of water. The piles were about 14 inches square and 23 feet long, and were each reinforced with four 1-inch diameter round bars, which were tied together at intervals by wire. After being made, the piles were permitted to remain in the molds for three days, after which they were removed and allowed to harden for two weeks before being driven. They were shod with iron and driven by a pile-driver, with a tup weighing 8,000 pounds, having a drop of 4 feet. The safe load was calculated by the following formula of Brix:

$$p = \frac{h\ Q^2\ 3}{2\ e\ (Q + 3)^2},$$

where p = safe load in kilograms; h = height of fall in centimeters; Q = weight of hammer in kilograms; e = the amount of penetration for the last blow of the hammer in centimeters, and 2 is a coefficient of safety.

NEW STORE OF HAMMACHER, SCHLEMMER & COMPANY.

The long-established firm of Hammacher, Schlemmer & Co., dealers in tools and supplies for manufacturing establishments and also dealers in hardware, now occupy their new and commodious building at Fourth Avenue and 13th Street, near Union Square, New York, as already announced in our advertising columns. Since the formation of the original company their home has heretofore been on the Bowery, and for many years in the familiar store at 209 Bowery, New York. In their new home they have considerably more room than before, and their quarters are more spacious, attractive and better adapted to the growing needs of the firm in every way than was the old building. The new structure is seven stories high, of steel frame construction, finished in combination brick and stone, and has a floor space aggregating about 40,000 square feet, with an opportunity for future enlargement. The division of the building is as follows: First floor, devoted to retail sales room; second floor, to main offices; third, to shipping and receiving departments; fourth, fifth, sixth and seventh floors and basement, to stock room. The building fronts on Fourth Avenue and has an L running to 13th Street, which is used for private offices, stock rooms, cloak rooms, lavatories, elevators, etc.

William Schlemmer, President and General Manager.

While Hammacher, Schlemmer & Co. are probably better known to our readers as dealers in tools than in any other capacity, the most important branch of their business consists in supplying manufacturing plants, especially those in metal working lines, with manufacturers' supplies of various kinds in large quantities. They carry six distinct main lines of goods, consisting of general factory supplies, tools for all trades, bolts, screws and nuts, cabinet hardware, builders' hardware and piano supplies. They deal with manufacturers and consumers direct, not selling to jobbers except in the case of certain specialties which they control. Their salesmen travel throughout the United States east of the Mississippi, and through Canada. An inventory of stock has shown from 8,000 to 10,000 items of different kinds of articles and from 70,000 to 80,000 total items, counting different sizes of the same article. These items, as a matter of course, are mainly in staple lines for which there is constant demand, but they have always had to supply many special things not usually carried by supply houses.

Numerous catalogues and circulars are published for the purpose of listing the stock in convenient form for different classes of purchasers. About 150 catalogues or circulars are in use. The tool catalogue, which many of our readers possess, contains 800 pages; one of bolts, screws and supplies, 193 pages; one of builders' hardware, 283 pages; one of cabinet hardware, 407 pages. There is a special circular, devoted exclusively to planes, containing 43 pages, and many other classes of supplies, tools or hardware have separate circulars, of which the following items, each the subject of a circular, will give an idea:

Tool Chests; Clamps, Hand Screws, etc.; Dowels, Birch, etc.; Handles (File, etc.); Files and Rasps; Leather Fillets for Patternmakers; Hollow Setscrews; Outfits of Tools for Home Use; Rivets and Burrs; Screwdrivers; Spring Cotters; Tools of all kinds; vises of all kinds; Miter Boxes; Imported French Band Saws.

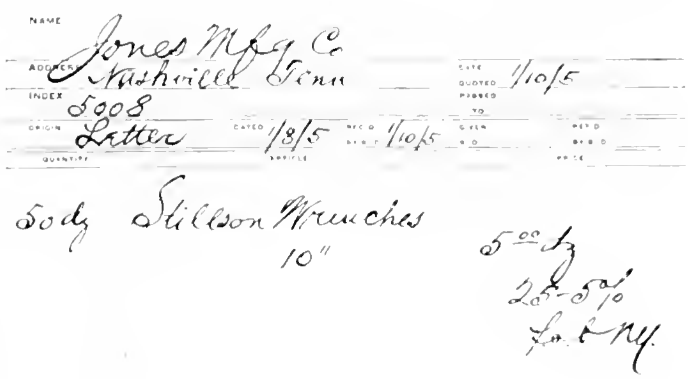
In the retail store half the area is devoted to hardware and the other half to tools. All the shelving, drawers, etc., were built especially to order to fit the stock carried, and the plan followed in laying these out was to take samples of the goods to go in a certain drawer for example, place them on a sheet of paper the size of the drawer, and mark around each piece showing the place taken. This paper then served as a guide to the cabinet maker in locating partitions. The cabinet work is in oak and is handsomely executed. The retail store is in communication with the other departments by means of dumb-waiters, pneumatic tubes for carrying orders, etc., and telephones, so that if a customer wishes a larger quantity of anything than is carried in the store, it can easily be sent down from the stock room. A label on the side of each drawer tells in what department the surplus stock is carried.

In the stock rooms where the orders are filled it has been necessary to work up a system for taking care of the orders that is as nearly automatic as possible. In filling orders for small parts it might happen, for instance, that one or more of the items was not in stock at the time the order was placed, and if the stockkeeper deferred making up the balance of the

New Store of Hammacher, Schlemmer & Co., Dealers in Tools and Supplies

order until the missing stock was received, he might at that time be no better off because some of the other items might not be on hand. To avoid this there are drawers and bins arranged in a department where the material for all incomplete orders is placed and remains until the balance of the stock is received, unless the customer wishes the incomplete order shipped first and the balance later.

In the main offices, also, the system by which the business is kept track of, both on the outside and inside, is as nearly automatic as possible. This matter of keeping track of inquiries is a problem in itself which every dealer and manufacturer has to work out in one way or another. The system used in this store has been in operation for several years with satisfaction, and it will be of interest to refer to it briefly. "Quotation Tickets" are employed, one of which is shown on a reduced scale in Fig. 3. Let it be supposed that an inquiry has come in for a price on 50 dozen 10-inch Stillson wrenches from the Jones Mfg. Co., Nashville, Tenn. The name of the firm and the address are entered as shown. The inquiry has come by letter, as indicated under the heading "Origin" at the left, followed by the date the inquiry was received. A clerk in the sales department enters the date the inquiry is received by him if he is to make the quotation, and he also fi[lls i]n the date on which the quotation was made, and under the heading "Price," the price quoted the Jones Mfg. Co. In case a card must be passed to the buying department to secure data for the quotation, the blank space to the right of "Given B. D." is filled in with the date on which the card is handed in to the department and when the card is returned they fill in the date opposite "Ret'd by B. D." This shows at once where a delay has occurred. If it is necessary to pass the inquiry to other hands to be followed up, as for example, to the export department; or if the inquiry has come through a salesman and it is desired that he should attend to the matter, the name of the


NAME Jones Mfg Co
ADDRESS Nashville Tenn
DATE QUOTED 1/10/5
INDEX 5008
PASSED TO
ORIGIN Letter DATED 1/8/5 REC'D 1/10/5 GIVEN B. D. RET'D B. D.
QUANTITY ARTICLE PRICE
50 dz Stillson Wrenches 10"
5.00 dz
25-5%
f. o. b. NY.

Quotation Ticket for keeping a Record of Inquiries and Quotations

person receiving the card would be filled in opposite the heading "Passed to," and when the person, or department, is through with it the date of return will be entered in the space marked "Ret'd." When the quotation is finally made or the inquiry followed up, the card is placed on file under the index number corresponding to the Jones Mfg. Co. Provision is made, in replying to an inquiry, for following it up at a later specified date, by stamping on a carbon copy of the reply, which is placed in a special file, the date at which the matter is to be taken up. The volume of business done is so large that it is found advisable to give each customer a number and to have that number stand for that customer in all office records. The quotation cards filed under each number thus make a complete history of quotations furnished customers, where they can be referred to instantly.

The firm of Hammacher, Schlemmer & Co. began business some time prior to 1848, at 221 Bowery, moving in 1857 to 209 Bowery, where they remained until October of last year, when they moved to their new home at Fourth Avenue. Mr. William Schlemmer, the president and general manager of the business, came to the concern as a boy in 1853 and has never engaged in any other enterprise. He was born in Westphalia, Germany, of German Lutheran parentage, in 1841. He is foresighted and an indefatigable worker, with great persistency of purpose. In 1893 a corporation was formed under the New Jersey law, but the name of the firm remained unchanged.

* * *

The recently completed East Boston tunnel, extending from Maverick Square, East Boston, to Court Street, Boston, is 7,450 feet long, mostly under water. At its deepest point the tunnel's bottom is 10 feet below the 40-foot dredging line at the bottom of the harbor. The tunnel has two tracks and is noteworthy for its liberal size and the absence of short curves. The tunnel walls are of concrete, which is reinforced at a few special points by steel tie rods. The electric power is conveyed, not by the third rail as in the New York Subway, but through a trolley wire. Experiments are being carried on looking to the replacement of the trolley wheel by some other form of a collector which will cost less for maintenance, various systems used abroad which replace the trolley wheel by a sliding bar of aluminum or other metal at right angles to the trolley wire being well thought of. One of the most interesting features of the tunnel is its lighting, there being over 600 incandescent lamps in service, spaced 12 feet apart, in three rows, throughout the tunnel. The building of the tunnel took about four years and seven months.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

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LESTER G. FRENCH, Editor.
FRED E. ROGERS, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

MARCH, 1905.

NET CIRCULATION FOR FEBRUARY, 1905,—23,164 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

An illustration of the difficulty sometimes experienced in getting work done right is given in the January issue of *The Locomotive*. It shows the disposition manifested by some men to expend much energy to conceal rascality in the erection of work, which, if properly directed in the first place, would have made a first-class job. In the inspection of a steam plant by one of the inspectors of the Hartford Steam Boiler Inspection and Insurance Company, it was found that the bolts used to join the pipe flanges were in some cases too short, the ends of the bolts lacking a number of threads of projecting through the nuts. The inspector ordered that the short bolts be removed and new bolts be put in, giving a full length of thread to all the nuts. The piping ran across the upper part of the boiler room where the air was exceedingly hot and uncomfortable, hence the task of replacing the bolts was not a very pleasant one. Instead of replacing the faulty bolts, the rascally workman sawed short pieces from other bolts and screwed them into the nuts, thus giving them the appearance of full-thread bolts, and it was only by close inspection that the fraud was discovered. Here apparently is a case where a workman, to save himself a little discomfort, was dishonest enough to conceal a botched job, which perhaps endangered the lives of the power plant employes. In general, it may be laid down as a principle that no man who is not honest can make a first-class workman. The dishonest or deceitful mechanic perhaps could not do close work because the necessary love for truth and accuracy is not in him.

* * *

GERMAN VIEW OF AMERICAN INDUSTRIES.

In one of his characteristic consular reports, Mr. Frank H. Mason, formerly of Berlin, Germany, and now of Paris, France, gives an interesting view of German industrial conditions as regards American competition. Many Germans were visitors to our Louisiana Purchase Exposition, and while in this country took the opportunity of visiting many of our leading shops, and gathering new ideas and impressions of our industrial organization. They have gone home again with much to praise and some things to censure. While admitting freely the boundless resources of our country, the energy, industry, and unsurpassed mechanical skill of the people, the superiority of our factory system, the speed and cheapness of rail transportation, and the restless, progressive spirit which is always looking for a new or better machine and method than the one already in use, the German experts find, or think they have found, defects in many parts of the American system, which, unless reformed, will continue to weaken our grasp upon international trade.

They severely criticise the careless confidence with which agents and salesmen are sent abroad with no special preparation, and with no knowledge of any language except their own. They are amazed at the meagerness of technical education, the trifling annual contingent of chemists, engineers, electricians, dyers, weavers, etc., as compared with the throng of lawyers, physicians, dentists, and unspecialized graduates turned out by our colleges and universities; also the number of graduates from our so-called "commercial colleges," where young men with common school education receive a three months' course in bookkeeping and commercial usages, and believe they have a finished education. In this lack of thoroughness in preparation, they see the weakening of our hold on industrial progress. They believe that the tide of improvement in manufacturing in Europe will swamp America, if she does not grasp the situation and reform.

It has come to be pretty generally believed in this country that the foreiguer, especially the German workman, is slow to grasp mechanical improvements and is necessarily a plodder. That this may be a serious mistake on our part is illustrated by an incident which occurred in a large machine shop in Berlin. The manager, preliminary to ordering a new American machine tool, sent to the factory in the United States sample pieces to be worked on the machine in order to ascertain precisely the time that would be saved, and how well the work would be performed. Among the pieces forming the test was one which had been roughed out to the required shape in seven minutes, and it was tagged to that effect. The lathe was ordered, and the American manufacturer soon after visited the German shop and was shown the piece marked seven minutes, with some deprecatory remarks, the Germans believing that such quick time was impossible and that it would take nearer an hour. The American offered to demonstrate it on the lathe which had just been made ready for work, but the German foreman objected, saying that it was unnecessary, for if the American could do it in seven minutes, he could do it as quickly. Two days later he reported that under his supervision, the lathe had done the work in five minutes.

The above would indicate to the thoughtful mind that men of average ability and intelligence are pretty equally matched when a proper incentive is given them to do their best. While the average German workman may be constitutionally slower than our American workmen, the probabilities are that he will be a good second with improved shop conditions, and this with the cheaper mode of life prevalent abroad, will soon make him a most formidable competitor in the machine tool and allied trades which have been regarded as safely within the sphere of American influence.

* * *

The manufacturers of a portable boring bar for steam engine cylinders show photographs of their apparatus in use, boring the valve chambers and cylinder of a Corliss engine. In the view showing the port boring operation, the cylinder head is on and evidently the piston is in place; in the view showing the cylinder boring operation the valves are in place and the valve chambers closed. A correspondent has criticised these operations, claiming that it is very bad practice to bore the cylinder of a Corliss engine without taking out the exhaust valves, or to bore the valve chambers without taking out the piston. While in general we must agree with our correspondent, it can be done with safety in the way illustrated if reasonable precautions are taken. In railway practice valve seats are frequently faced without removing the pistons, the ports being carefully fitted with strips of wood which prevent all chips and dirt falling into the ports; and the same can be done in the port or cylinder boring operations on a Corliss engine. The time saved in dismantling and assembling an engine where only one part is to be repaired is well worth consideration, both in the cost of the labor and in the time saved, but the practice criticised is one that cannot be safely followed unless great care is taken.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Mechanical appliances are coming more and more in evidence in the business office as their labor-saving qualities are recognized. A calculating machine is one of these time-saving devices which not only saves time but which insures accuracy of results. The latest development in this line is the addition of an adding attachment to an ordinary typewriter, which not only totals a column of figures but acts as a check upon the accuracy of same. When the typewritist has written the various items of a bill, the sum total is indicated on the adding wheels and is typewritten the instant the items are completed.

The almost universal practice of applying belts to machines requires that as the belt grows slack a piece shall be cut out, to take up the slack. This practice not only wastes the belt, but requires that the end cut off shall be carefully squared up and new belt holes punched in it. The Morse Chain Co., Trumansburg, N. Y., we understand, follow a different practice. They deliberately cut their belts too short, when they are first applied to the machines, by a length of a foot or 15 inches. This must, of course, be filled in by an extra piece. When the belt grows slack this piece is removed and a shorter piece inserted instead. A variety of widths and lengths is kept in the toolroom for this purpose, and when a machine operator wishes to shorten his belt, he determines about how much slack needs taking up, and calls at the toolroom for a piece that much shorter than the one already in the belt. The old piece is returned to be used again as occasion requires.

It is with reluctance that telephone and telegraph companies put their wires underground in cities, but this does not arise altogether because of the cost. Although the cost is heavy, the freedom from interruption of the service because of storms, fires, and other accidents to which overhead wires are subject, largely compensates for it. The chief difficulty lies in the extraordinary increase in the induction of an underground cable as compared with a line wire. It is stated that one mile of underground wire has as great an effect in cutting down the effective transmission as 20 to 25 miles of overhead wire, and that 15 miles of underground circuits in New York City cuts down the current as much as over 800 miles of overhead circuits. In other words it requires as much energy to transmit the current through 15 miles of underground circuit in New York City as from New York to Chicago by the overhead wires.

We are indebted to *Popular Mechanics* for the description of a portable home-made planer, built by an electric railway company in California which had occasion to plane several hundred wooden trolley poles, and found it difficult and expensive to haul the poles to a mill. This consisted of a planer head mounted on a substantial wooden truck and belt-driven by a 5-horse power 500-volt direct-current General Electric motor. The rollers were made of two sections of 10-inch wrought-iron pipe, castings being fitted in the ends for the axle bearings. A pair of plow handles were used to push and guide the planer, the starting box for the motor being mounted between the handles. The entire outfit cost but $60 outside of the motor, which the company had in stock. The poles were 35 feet in length, with 8-inch tops, and it took about one minute to plane down one of the four sides of a pole. The poles were planed as they were unloaded from the cars, at the rate of six poles an hour. There was not only considerable saving in time, but also a great saving in expense, as it cost but ten cents per pole as against $1.15, the price estimated for doing it by hand.

According to the *Electrical Review*, of London, the Great Northern Railway of England has been experimenting with gasoline motive power for suburban traffic. The motive power is generated by two Daimler gas engines of 36 H. P. each. These engines drive onto a common longitudinal shaft which is connected to the two axles of the car by beveled gearing. To overcome the difficulty of one axle overrunning the other, owing to any possible inequality in the diameter of the wheels or for other reasons, a special form of differential gear is introduced, combined with which is the reversing mechanism. The engines are connected through independent clutches to a common change speed box, from which the power is transmitted through the longitudinal shaft to gear boxes suspended on each axle, from which point the speed is reduced by means of single reduction gearing.

A separate gasoline tank is provided for each engine, and the combined capacity of these is sufficient for 400 car-miles. The car is lighted by electricity obtained from storage batteries, which also supply energy for ignition and for the magnetic clutches. The weight of the car, including passengers, is 16 tons, and it is designed for a speed of 30 miles per hour, although it has on several occasions surpassed a speed of 50 miles.

Although artificial gas has a heating value of only from 650 to 700 British thermal units per cubic foot, and a thousand cubic feet, costing in many American cities about $1, contains approximately one-thirty-sixth the heating value of a ton of anthracite coal, hence costs six times as much as coal at $6 a ton, yet, on account of its advantages of convenience, cleanliness and adaptability, gas has obtained a strong foothold as a means of heating buildings. It is particularly valuable for intermittent heating of such buildings as churches, lodge rooms, and other meeting places where heating is required for short periods only during each week. With coal heating a large portion of the heat is wasted, inasmuch as a heavy fire has to be started which perhaps lasts some hours after the need for it is over. With gas heating the fire is easily started, and while it must be started some time previous to the time the heat is required, of course, it can be discontinued immediately after such need is over; but from the point of economy gas heating should be done by gas radiators located in the room. These should be provided with suitable ventilating devices so as not to vitiate the air with the products of combustion.

Smith & Coventry, Manchester, England, it is claimed, have applied a cushion planer drive to their line of planers with very satisfactory results. The drive from the pulley shaft is transmitted through single reduction spur gearing to a large spur gear outside the bed, which is mounted on a shaft carrying a pinion, which engages with the usual bull-wheel meshing with the rack on the under side of the platen. The large spur gear outside the bed is mounted loosely on its shaft, but engaging with it is a clutch whose cam-shaped contour teeth engage with a similar shaped contour on the hub of the gear. The clutch is held against the hub of the gear by a powerful coil spring, the whole forming a combination similar to the well known Beaman & Smith tapping attachment. When the platen is reversed at the end of the stroke, the spring is compressed for an instant while the inertia is being overcome. It then extends again, giving up the energy stored in it, but does not quite close, the amount of opening corresponding to the work of moving the platen. It is claimed that this cushion drive works well and greatly reduces the shock of reversal on high speeds. It does not appear, however, that it overcomes the greatest difficulty in planer operation, and that is the momentum of high-speed reversing pulleys. The momentum of these pulleys on many designs of planers is far greater than the momentum of the platen and its load. The Smith & Coventry device merely takes care of the inertia of the platen, but contributes little or nothing to overcoming the momentum of the reversing pulleys.

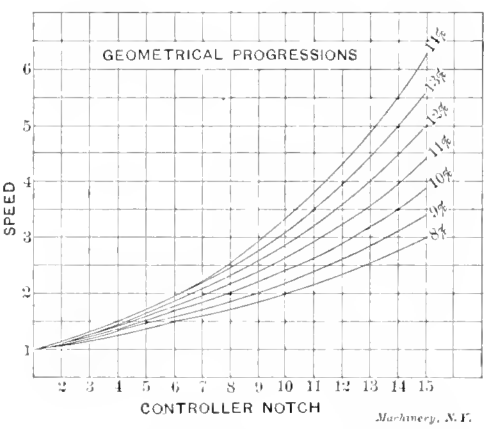
The subject of conductors for protecting buildings from lightning is one upon which there is much misinformation, and it appears exceedingly difficult to discover just what posi-

tion the lightning conductor occupies as a protector of property. Lightning rod agents have played upon the credulity of the public to such an extent that many scientific men have declared that lightning rods are of little or no use whatever. On the other hand it is conceded by others equally well-informed that when properly put up, the lightning rod is a valuable protector of buildings and tall structures, especially brick chimneys. According to Sir Oliver Lodge, who recently delivered an interesting lecture on the subject in Birmingham, an error that is frequently made in the installation of lightning rods is in using rods of too large cross section and of too high conductivity. He says that a copper rod is not as good as an iron rod, for the reason that a heavy copper rod lets down a current too quickly and produces a shock or collision because of the electric inertia or inductive effect; where a copper rod, say, a foot thick would be highly dangerous as a lightning conductor, an iron wire one-tenth inch diameter might be quite safe and effective. A heavy copper conductor is liable to side flashes, but a light iron wire allows the flash to leak down, as it were, and perhaps fuse it with little perceptible disturbance. A number of conductors are better than one, and are better when made of light iron wire than of heavy copper rod. Small iron wire may be fused and destroyed, it is true, but this contingency must be met by renewal. In fact the practice advocated would be very similar to the renewal of electric fuses, and the iron conductor and the fuse might be said to occupy analogous positions. When the fuse blows we expect to renew it, and the same holds true with the small iron lightning conductor.

APPLICATION OF MOTORS TO MACHINE TOOLS.

J. M. Barr, in the Electric Club Journal, January, 1905.

Machine tools are operated under such varying conditions that no general statement can be made covering all of them. Some of the governing conditions which should be taken into account in fitting a motor to a tool are the character of the work, the kind of material cut, the shape, quality, and method of treatment in making the cutting tool, the stiffness of the machine, etc. Whatever the class of machine tool, the variable speed motor generally offers decided advantages for driving, especially with the use of the new high-speed steels. The latter, when working at economical rates, require such pulling power in belts and increased strength in gears, that reasonably fine increments in speed are almost impossible by mechanical methods alone, owing either to the



increased length of the cone pulley or the great size of the change gears. These fine gradations of speed are necessary if the tools are to be worked up to their limit of capacity.

With the variable speed motor, approved practice is to make the ratio between the various cutting speeds increase in geometrical progression. To aid in calculating the speeds for the various controller notches the curves given herewith have been prepared. In this figure the horizontal represents the controller notches and the vertical the multiples of speed for the various notches, with given increments of speed for each notch. For instance, on the fourteenth notch of the controller having 14 per cent increments, the speed would be 5½ times the initial speed. These curves are based on standard practice, in which eight notches are used on the single voltage and fifteen on the double. The controller should be as handy for the operator as possible. In the case of a lathe, good practice places the handle on the tool carriage.

The following formulas for horse power will be useful, especially for estimating, for tools operating under the given conditions. These are for a cutting speed of about 20 feet per minute, water-hardened steel cutting tools, and normal machine tools, as distinguished from the modern high-speed tools. For cutting speeds greater than 20 feet per minute, the horse power required should be increased approximately in proportion to the increase in speed.

For tools having rotary motion, motors should be shunt wound, variable speed.

1. *Lathes*—Engine lathes using one cutting tool:

$$\text{H. P.} = .15\,S - 1 \text{ H. P.}$$

Heavy engine lathes:

$$\text{H. P.} = .234\,S - 2 \text{ H. P.}$$

In which $S =$ swing of lathe in inches.

2. *Boring Mills.*—Particularly for mills having a 30-inch swing and above:

$$\text{H. P.} = .25\,S - 4 \text{ H. P.}$$

Where $S =$ swing of mill in inches.

For smaller mills the formula for heavy engine lathes is approximately correct.

3. *Milling Machines.*—Where $W =$ distance between housings in inches:

$$\text{H. P.} = .3\,W$$

4. *Drill Presses.*—For normal drill presses using water-hardened steel drills, running at a peripheral cutting speed of approximately 20 feet per minute:

$$\text{H. P.} = .06\,S$$

For heavy radial drill presses:

$$\text{H. P.} = 0.1\,S$$

Where $S =$ capacity of drill in inches.

For tools having reciprocating motion, a variable-speed motor with compound winding should be used, as the latter winding assists in holding down the inrush of current at the moment of reversal, when the torque required rises considerably above the normal.

1. *Slotters.*—Normal crank slotters, using water-hardened steels at cutting speeds of from 15 to 20 feet per minute:

Stroke.	Horsepower.	Stroke.	Horsepower.
10 inches.	5	30 inches.	10
18 "	7		

2. *Shapers.*—Shapers using water-hardened tool steels at cutting speed of from 15 to 20 feet per minute:

Stroke.	Horsepower.	Stroke.	Horsepower.
16 inches.	3	24 inches.	5
18 "	3½	30 "	6½

3. *Planers.*—For normal planers using water-hardened steel at cutting speeds of from 15 to 20 feet per minute:

$$\text{H. P.} = 3\,W$$

For heavy forge planers:

$$\text{H. P} = 4.92\,W$$

Where $W =$ width between housings in feet.

The above formulas are for planers having a ratio of cutting to return speeds of approximately 1 to 3, and cover planers with two tools in operation. If more than two tools are used, or if the ratio between the forward and return speeds is more than 1 to 3, the horse power given by above formulas should be increased.

Attention is especially called, in the use of these formulas, to the low cutting speeds to which they directly apply.

LATHE FOR TURNING ELLIPSES.

Der Pratische Maschinen Konstrukteur, July 21, 1904, p. 117.

An ingenious lathe for turning elliptical sections has recently been brought out by Ch. Montreuil, the principle of whose action is as follows:

In Fig. 1, let O be a center about which a circle is described with OA as a radius. Let this be equal to R. With A as a center and $AB = r$ as a radius describe a second circle. If now A be rotated about O, and B be rotated about A with twice the angular velocity that A has about O, then B will describe

an ellipse with a major axis equal to $R + r$ and a minor axis equal to $R - r$. Suppose the line OA turns through the angle a to OA_1, Fig. 2, and at the same time, the outer portion AB has turned in the opposite direction through an angle equal to $2a$. The point B then lies at B_1, which is well known to be a point on an ellipse. The normal to this ellipse at the point B_1 passes through the point O_1 on the line OA_1 at a point that makes $OA_1 = A_1O_1$. If an ellipse were to be generated by the point B_1 while revolving about its center O, and B should be in constant motion with the ellipse while A is fixed, then B would make two revolutions about A in the direction of the ellipse. At the same time O_1 would be a fixed point through which all normals whatsoever of the revolving ellipse would pass. A tool set in the line of the normal $O_1 B_1$, with its cutting point at B_1, would cut a true ellipse from a piece of work revolving about O. The relative positions of the points O_1, A_1, O and A_1 B_1 must, therefore, be such that $OA_1 = A_1 O_1 = R$, and $A_1 B_1 = r$, and the semi axes of the ellipse cut by the tool be:

$$a = R + r \text{ and } b = R - r$$

In the application of this principle to the construction of an ellipse lathe, M. Montreuil has taken an ordinary lathe and limited the changes that need be made almost exclusively to the carriage so that the machine can also be used for ordinary turning. In Figs. 3 and 4 the arrangement and movements are shown diagrammatically. The line CD, Fig. 4, represents the tool and corresponds to the normal $B_1 O_1$ of Figs. 1 and 2. It passes through the fixed point P. The point C describes a circle x having a radius $\frac{a - b}{2}$ about S as a center. OS_1 is equal to $R = \frac{a + b}{2}$; $A_1 B_1$ is equal and parallel to $C_1 D_1$ and passes through the fixed point O; $D_1 B_1$ is parallel to PO. While the point C describes its circle about S with the radius $\frac{a - b}{2}$, the point A moves through the circle x_1 of the same diameter, so that $B_1 D_1$ is always parallel to PO.

Figs. 5, 6, 7 and 8 give front and end elevations and a plan of the lathe to which this principle is applied. The piece to be turned is held between the centers of the lathe, and the tool k_1 cuts it in a direction normal to the curve of the ellipse, having itself a circular motion. For this purpose the toolpost k is moved in and out in the carriage slide, which, in its turn, can swing through the arc of a circle. The toolpost k corresponds to the line AB of Fig. 4, which passes through the center of the semicircular opening to the fixed point O. In the following explanation of the principle of operation of

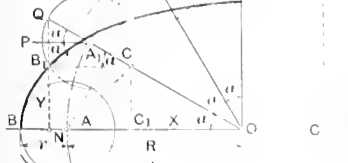


Fig. 3

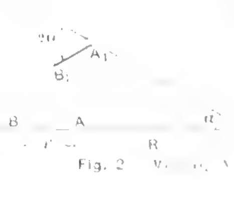


Fig. 4

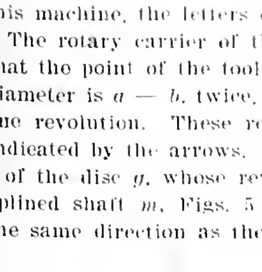


Fig. 1

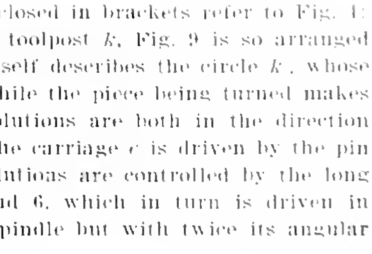


Fig. 2

this machine, the letters enclosed in brackets refer to Fig. 1.

The rotary carrier of the toolpost k, Fig. 9 is so arranged that the point of the tool itself describes the circle k, whose diameter is $a - b$, twice, while the piece being turned makes one revolution. These revolutions are both in the direction indicated by the arrows. The carriage c is driven by the pin f of the disc g, whose revolutions are controlled by the long splined shaft m, Figs. 5 and 6, which in turn is driven in the same direction as the spindle but with twice its angular velocity by means of the intermediate gears m_1, and ... tion is transmitted to the disc g through the gears ... n. This, then, moves in the same direction but with ... the speed of the working ellipsoid, so that the point of the tool makes two revolutions while the piece being operated upon makes but one. The shaft of the intermediate gear ... is carried by two swinging arms, p, p_1, by means of which it can be thrown out of gear if a circular piece is to be turned. The pin f (C) of the disc g can be moved to or from the

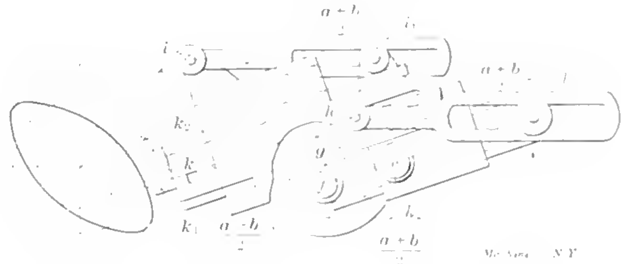


Fig. 9. Detail of Movement of Lathe for Turning Ellipses

center (S) by means of a screw whereby the circle described by it or the tool point may be adjusted so that its radius $r = \frac{a - b}{2}$. By varying this radius an ellipse with any ratio between the major or minor axes can be turned. From this it will be seen that the actual circular motion of the tool is obtained as the resultant of an oscillating motion in the arc of a circle and the vibratory motion of the toolpost. The feed of the cutter is obtained from the leadscrew, Figs. 5 and 6, driving a nut attached to the carriage in the usual way.

PRODUCER GAS ENGINES ON SHIPBOARD.

Marine Engineering, January, 1905.

Bernard A. Sinn, writing in the above magazine, tells us that the gas engine, and probably eventually the gas turbine, will be the solution of the propelling question for marine purposes. This engine or turbine will, apparently, be supplied from a gas producer plant installed on shipboard, since the high price of liquid fuel has so far prevented the adoption of gas engines of large powers for ship propulsion. Some success has been met with in the equipment of vessels with oil engines, but serious objections are presented to this type in the higher insurance rate demanded, owing to the popular belief that oil fuel is difficult to handle, and in the non-reversibility of the engine. In order to drive astern a vessel so equipped the use of heavy reverse gears is customary. Gears to reverse an engine of 5,000 I.H.P. having an 18-inch crankshaft, would needs be 12 feet in diameter and of 4 foot face.

Manufacturers of marine gas engines in the last two years are, however, building engines that may be reversed by compressed air. This is accomplished by cutting off the gas, turning the cam shaft 90 degrees, and sending compressed air into the cylinder, when the change in the time of admission and exhaust is sufficient to catch the engine in the reverse motion in one of the three cylinders and reverse the same. As soon as the engine is started in the opposite direction gas is admitted through the proper valves, the time of ignition arranged to suit, and the engine operated in the reverse direction in the same manner as previously in the go-ahead motion. All this is accomplished with one lever and valve, the lever operating the cam and ignition shafts and both of the compressed air and gas valves.

A gas propelled vessel needs, in addition to the main driving engines, exhausters for the gas producers, an air compressing plant to reverse the main engines, operate other gear, and blow the whistle, circulating pumps for circulating water through the main engines, and to give water to the steamer or the producers, and other auxiliaries not directly used for the main engines. An electric plant should be installed on board, direct-driven from the engines. This will furnish power for running the auxiliaries more cheaply than would be possible by the direct use of the steam. Electrically driven pumps are now made of a higher efficiency, and much more economical, than direct driven steam pumps. The compressed air would

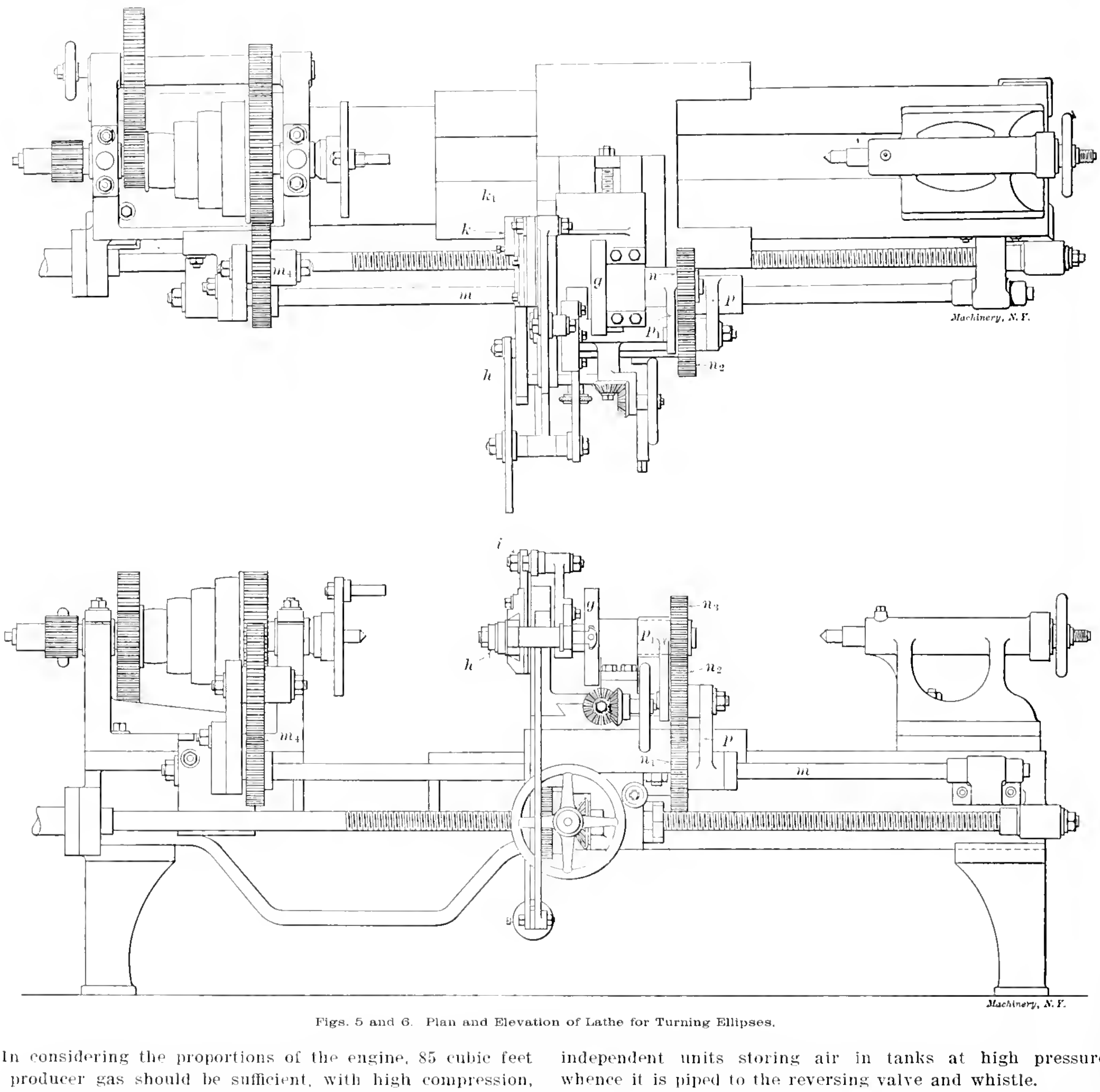
be furnished by a small, electrically-driven air compressor for the start, and, if desired, from the main engines when running. These machines are now built so that the power is regulated by the pressure, so that practically a constant air supply is furnished.

In considering large powered gas engines for marine purposes, it is necessary to turn to land practice for the necessary information. Vertical gas engines of 3,000 to 5,000 H.P have been successfully installed, both in this country and abroad, for the production of electric and other power. The four-cycle engine, as built to-day in large powers, can be safely recommended as the best adapted type for marine purposes. A three-cylinder, double-acting, four-cycle engine giving six explosions in each two revolutions, the same as a two-cycle single-acting engine, would be suitable.

Cam shafts and ignition shafts are operated by gearing from the main shaft. For each valve there should be three cams, one for forward motion of the engine, one for going astern, and one for operating the valve when the engine is being reversed. For this purpose the cams are movable on their shaft, and moving and locking devices are provided.

The piston is convex on top and bottom, and is ground into the cylinder. Stuffing boxes are very deep, with heavy packings. Cylinders, ports, valves, chests, exhaust valves, pistons, tail rods and connecting rods are water-cooled. The material for an engine of this type must be the strongest.

The gases, after being burned in the cylinder, are led to a muffler, where the sound of explosion is reduced, and the heat in the exhaust gases utilized for heating water for heating purposes. The air compressing plant consists of two



Figs. 5 and 6. Plan and Elevation of Lathe for Turning Ellipses.

In considering the proportions of the engine, 85 cubic feet of producer gas should be sufficient, with high compression, for 1 I.H.P. Piston speeds have not yet risen above 800 feet per minute. A mean effective pressure per explosion of 70 pounds should be obtained. From these considerations the size of the cylinders is determined. The speeds of the inlet and exhaust gases should be 100 and 85 feet per second, respectively, and valves and ports should be designed accordingly. Valves should have an area of 15 to 20 per cent of the cylinder area, and should have very quick action. The mixture should be of about equal parts of producer gas and air. The compression space for a compression of 150 pounds per square inch should be one-quarter the volume of the piston displacement.

independent units storing air in tanks at high pressure, whence it is piped to the reversing valve and whistle.

The electric plant is the most important of the auxiliaries. As soon as the starting producer is supplying gas the electric plant is ready for operation. It must store up energy in the accumulators; be ready to operate such pumps as require to be used; drive the blowers for starting the main generators, and also the exhausters for supplying gas to the main engines; it must run the various small pumps throughout the vessel, the deck machinery, steering gear and windlass, and supply light as needed, and supply the ignition spark for the engines. The dynamos are connected to the gas engines and the piping is so arranged that the gas engines may take gas either from the starting machines or from the main producers.

As the storage batteries also are connected to the main switchboard the motors may be operated from generators or from storage batteries.

The two main driving engines, with their thrust bearings, as is customary in twin-screw vessels, occupy the center of the engine room space. On each side on the floor are air compressors and tanks and such pumps as are necessary. On platforms built at the forward end of the engine room are the exhausters which suck the gas from the gas generators and deliver it to the engine. On a platform at the after end of the engine room are the dynamos. Above the hold stringer on each side are the mufflers and hot water heaters, and in the lower 'tween decks the refrigerating plant, machine shop and other small auxiliaries. The storage batteries are placed well out at the side between the frames and on the stringers. The blowers for starting the generators are also situated in the engine room.

WEIGHTS FOR 10,000 I. H. P. MARINE ENGINES

Steam Power Vessels.	Tons.	Gas Power Vessels.	Tons.
Main engines	385	Main engines	465
Condensers	56	Heaters and mufflers	22
Boilers	315	Generators	165
Uptakes, stacks, etc	86	Relief and exhaust pipes	38
Fans, feed heaters, etc	41	Exhausters and blowers	36
Pumps and auxiliaries	19	Compressor air plant, pumps, etc	66
Electric light plant	20	Electric plant	40
Spares and sundries	15	Spares and sundries	18
Donkey boiler, complete	32	Starting machines	22
Water in boilers	180	Water in generators, etc	15
Total	1,149	Total	927
Coal	1,950	Coal	1,000
Grand total	3,095	Grand total	1,927
First cost	$295,300.00	First cost	$246,200.00
Cost per I. H. P.	29.53	Cost per I. H. P.	24.62

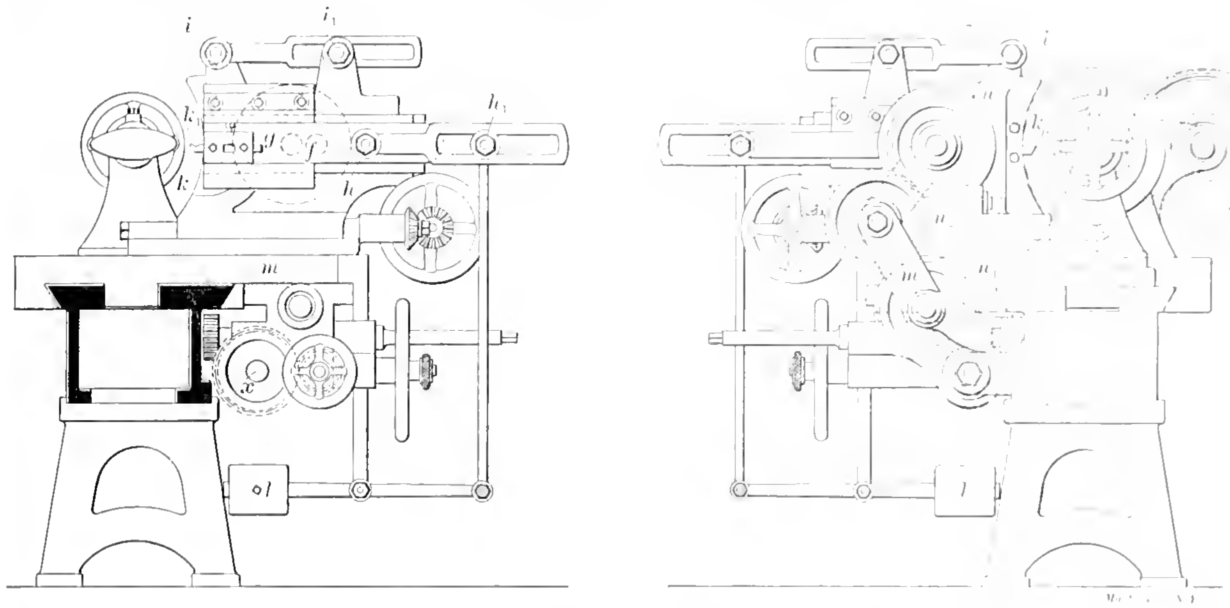
	Steam Power Vessel.	Gas Power Vessel.
Interest, depreciation, and insurance	$27,620	$21,480
Coal, annually (150 days' steaming)	90,000	48,500
Service (engine and fire room crews)	30,000	12,000
Oils and stores	3,650	5,600
Repairs and sundries	15,000	12,000
	$166,270	$99,580
Annual saving	$66,690	
Added cargo capacity 1,150 tons.		
Value of added cargo carried	46,000	
Total saving	$112,690	

being about 10 per cent. on the whole cost of the vessel.

In the above tabulated statement a comparison of costs and weights for a 10,000-I.H.P. plant is made by the author, and a decided saving in first cost, in operating expenses, in space, in weight, and an increase in carrying capacity and a large increase in earning capacity are shown, so that the future of gas-propelled vessels would seem to be assured as soon as engine builders supply proper machines.

A COMMERCIAL UNIPOLAR DYNAMO.

A paper presented by Mr. J. E. Noeggerath at the Jan. meeting of the American Institute of Electrical Engineers on the subject of "Acyclic (Homopolar) Dynamos," describes a dynamo of the type usually known as unipolar, recently designed and built in the shops of the General Electric Company. As this is a type on which investigators have worked for years without producing anything of practical value, the apparent success of the 300-kilowatt 500-volt, turbine-driven acyclic generator described by Mr. Noeggerath has excited a great deal of interesting discussion.



Figs. 7 and 8. End Elevation of Lathe for Turning Ellipses

The earliest type of generator, the Faraday disk, was a homopolar machine which developed only a fraction of a volt e. m. f. Since that time, many designers have attempted to build commercial machines of this type, without success, on account of insufficient speed and mechanical and magnetic difficulties. Mr. Noeggerath has been aided in his machines by the advent of the high-speed dynamo.

Acyclic (non-cyclic) generators are classified according to the position of the armature conductors, as the radial type, having one or two disks, and the axial type, having one or two cylinders, either solid or hollow. The generator here considered is of the cylinder type. It consists chiefly of a solid armature of mild cast steel, and a cast steel frame. On the smooth armature surface are longitudinally disposed 24 straight conductors insulated flat copper strips. These are connected at both ends to insulated steel collector rings, one of each pair of rings being on each side of the armature core. There are twenty-four of these rings, twelve on each side of the armature. The successive armature conductors are connected in series through fixed copper brushes resting on the rings and fixed connecting wires carried through the mass of the stator, or frame. The twelve collector rings on either side of the armature, of equal diameter with it, are assembled close together and mounted on a shell. The field is a cast steel structure extending toward the shaft in three polar projections that enclose the armature in complete cylinders. Two field coils are wound concentrically with the shaft. Eight openings in the frame give access to three brushes each, making a total of twenty-four contacts. The stationary circuit consists of twelve cables.

The machine here described was run at high speed by a steam turbine, developing 300 kilowatts, 500 volts, and an efficiency of 91 per cent. Various precautions are taken to neutralize the ring and armature reactions which tend to cause variations of the magnetic field. The brush friction has been a cause of much trouble in previous homopolar generators, but in this case does not seem to be so serious as feared, amounting to only about 500 watts.

The acyclic dynamo offers some considerable advantages for direct-current machines. It is a simpler type than any in use, returning to the smooth core armature, and eliminating the commutator and the attendant troubles. Another advantage is the perfectly uniform voltage given. There is no necessity for

laminating any of the parts, for because of its magnetic distribution there is but little hysteresis loss and but little tendency for eddy currents to be set up. As uniform a distribution of flux through the air gap is produced as possible. The machine is said to compound itself by simply shifting the collecting brushes. The regulation should be good. The air gap is reduced to a mere clearance, thus reducing the magnetizing force necessary. The generator should be a cheap construction, viewed all around, and as the mechanical difficulties of brush-friction while collecting current at the high speed used, etc., seem to be solved to quite an extent, a considerable step in advance has apparently been taken.

GAS ENGINE TESTING.

The Engineer, January 1, 1905.

In gas engine tests the observations to be taken should consist of the temperatures and pressures of the gas and air supplied; the temperatures of the entering and leaving jacket water and of the exhaust gases, of the volume of gas used, of the quantity of jacket water, of the number of explosions and revolutions per minute, and of the data necessary to determine both indicated and brake horse power of the engine, and of the engine constants. For making the test, thermometer cups should be inserted in the water pipe so that the temperature of the jacket water may be taken just before it enters and after it leaves the jacket. The water used should be piped to a tank resting on a scale, so that its weight may be ascertained at stated intervals. The gas consumed should be measured by a meter which has recently been calibrated, and it should be seen to that all gas consumed passes through this meter. The temperature of the gas should be taken by the thermometer hanging beside the meter, and the pressure above the atmosphere in inches of water by a manometer connected to the gas line.

The power developed in the cylinder is measured by an indicator similar to the steam engine indicator, which should, however, have a piston ¼ square inch in area, so that an excessively heavy spring will not be required on account of the high pressure in the gas engine. The indicator spring should be surrounded by a water jacket. Delivered power should be measured by some form of a Prony friction brake. Suitable forms are the band and lever type and the drum and rope type, but as these are well known they need not be described. The brake horse power may in some cases be measured without the use of a Prony brake, as for instance in the case of an engine direct-connected to a generator.

Before testing the engine, it should be put in good working condition. Valves should be inspected and reseated if necessary, the sparking apparatus should be overhauled, and the cylinder oil should be supplied uniformly to the cylinder. The most important facts concerning the engine which should be recorded are, its type; method of governing; method of ignition; kind of fuel used; stroke of engine; diameter of piston, and volume of clearance. The engine should be started up and run for at least an hour after the preliminary preparations have been made, in order that it may be thoroughly heated up and the conditions may become constant. The jacket water should be regulated so that it leaves at a temperature of about 160 degrees F., which is considered to be the best leaving temperature. The gas and air should be regulated for best proportions of combination, that is 1 to 10 when illuminating gas is the fuel used. It is very important that the scale reading should be kept constant. Average data for a test can usually be obtained from an hour's run, but if an endurance run is desired 7 to 10 hours should be sufficient.

Reading should be taken every ten minutes, and should be recorded as follows: Revolutions per minute; explosions per minute; cards taken from indicator; net force on brake arm; pounds of jacket water; temperature of entering jacket water; temperature of leaving jacket water; cubic feet of gas; pressure of gas in inches of water; temperature of gas at meter; temperature of exhaust gases; cubic feet of air; temperature of air. Barometric pressure and the heating value of fuel should be recorded once an hour. The gas consumed may be found for a short run by the rate method, that is, by recording the time in seconds for the consumption of 10 cubic feet of the gas. For long runs it is better to record the total quantity of gas consumed.

From the recorded data there should be computed: Indicated horse power; brake horse power; heat carried away by jacket water; cubic feet of gas (standard conditions); cubic feet of air (standard conditions); ratio of gas to air; British thermal units per indicated horse power per hour; British thermal units per brake horse power per hour; efficiencies of engine.

The indicated horse power is expressed by the formula:

$$\text{I. H. P.} = \frac{P\,E\,A\,L}{33{,}000}$$

in which P is the mean effective pressure in pounds per square inch, as obtained from the indicator card, E is the number of explosions per minute, A is the area of the piston in square inches, L is the length of the stroke in feet. $\frac{A\,L}{33{,}000}$ is constant for a given engine.

The mean effective pressure is found, as is well known, by dividing the area of the indicator card in square inches as measured by a planimeter, by the length of the card in inches, which product, the mean height of the card, is multiplied by the scale of the indicator spring. If the indicator has a reduced piston, multiply by twice the scale of the spring.

The brake horse power is computed from the formula:

$$\text{B. H. P.} = \frac{2\,\pi\,l\,N\,W}{33{,}000}$$

in which l is the distance in feet from the center of the brake wheel to the knife edge of the Prony brake, or the radius in feet of the brake wheel if a rope brake is used, N is the number of revolutions per minute, W is the net weight in pounds on the scales.

$\frac{2\,\pi\,l}{33{,}000}$ is constant for a given Prony brake.

If l is made 5¼ feet this constant is 0.001, so that,

$$\text{Brake horsepower} = \frac{N\,W}{1{,}000},$$

which is a very convenient formula in which to substitute.

Heat carried away by the jacket water in British thermal units is the product of the number of pounds of water discharged and the difference in temperature of the entering and leaving jacket water. The total British thermal units carried away per hour divided by the brake horse power gives the British thermal units taken away by the jacket water per brake horse power per hour.

Gas consumed must be reduced to standard conditions of pressure and temperature, in order to determine the cost in thermal units of each horse power hour.

The standard conditions usually taken are a pressure of 30 inches of mercury and 62 degrees F., and reductions are made to them by means of the formula,

$$\frac{p_s\,v_s}{T_s} = \frac{p_1\,v_1}{T_1},$$

in which p_s = 30 inches of mercury,

p_1 = pressure of gas at meter.

= barometer reading + (0.074 × reading of manometer in inches of water).

$T_s = 461 + 62 = 523$ degrees F.,

T_1 = absolute temperature of gas.

= temperature of gas at meter + 461.

v_1 = volume of gas registered by the meter,

v_s = volume required,

$$\text{Then } v_s = \frac{v_1\,p_1}{T_1} \times \frac{T_s}{p_s} = 17.43\,\frac{p_1\,v_1}{T_1},$$

since T_s and p_s are constants.

During any given test p_1 and T_1 are nearly constant so that

$$v_s = R_s\,v_1$$

$$\text{in which } R_s = 17.43\,\frac{p_1}{T_1}$$

If the barometer is 29.43 inches mercury, manometer 5 inches

water, temperature of gas 72 degrees, $v_1 = 349$ cubic feet, find the volume of gas for standard conditions.

$p_1 = 29.43 + (0.074 \times 5) = 29.8.$

$T_1 = 72 + 461 = 533,$

and

$$R_s = \frac{17.43 \times 29.8}{533} = 0.974.$$

Then, $v_s = 0.974 \times 349 = 340$ cubic feet.

If the air has been metered during the run, it may be reduced to standard conditions by the formula used for the gas.

The total British thermal units per hour is the product of the number of cubic feet of gas used per hour, and its heating value. The total British thermal units per hour divided by the brake horse power gives the British thermal units per brake horse power hour. The total British thermal units per hour divided by the indicated horse power gives the British thermal units per indicated horse power hour. By friction horse power is meant the difference between the indicated horse power and the brake horse power, or it is the indicated horse power when the engine is running under no load.

Efficiencies of the engine are of two kinds, thermal and mechanical. One horse power for an hour equals the performance of 1,980,000 foot-pounds of work, or the equivalent of 2,545 British thermal units. The ratio of 2,545 to the British thermal units per horse power gives the thermal efficiency of the engine.

The mechanical efficiency of the engine is the ratio of the brake horse power to the indicated horse power.

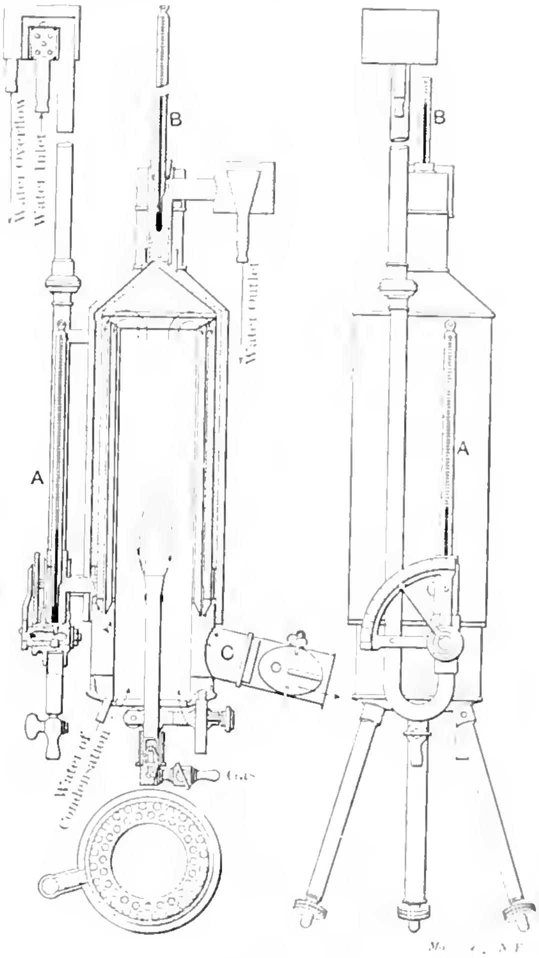
Besides these various quantities, the distribution of the heat supplied should be known in per cent; that is, the proportion of the heat supplied going to useful work, the per cent lost in engine friction, that lost through radiation, and that carried off by the jacket water and the exhaust, should all be calculated.

The determination of the heating value of the fuel is of course important for all these calculations. The best instrument for this determination is the Junker calorimeter. This instrument, which is shown in the accompanying figure, has the advantage of being portable, of burning the fuel at atmospheric pressure, and of being operated continuously for any length of time. It is essentially a device for abstracting the heat from the gas which is burned in the central chamber of the calorimeter, by a supply of water which passes around the outside of this chamber. The weight of this water passing in a given time and its temperature on entering and leaving are measured. The heat given up by the gas thereby becomes known. This calorimeter is used in connection with a test meter, a pressure regulator, a tank resting on a pair of scales for the cooling water, and a water manometer connected to the meter for measuring the pressure of the gas. The course of the gas is through the meter, the pressure regulator and calorimeter. The whole set is preferably enclosed in a glass case, so that currents of air may not affect it.

The section of the calorimeter to the left shows the gas flame in position. The gas enters as shown, and air is admitted through a regulating device just above it. The products of combustion ascend to the roof of the combustion chamber, pass down through the cooling tubes shown in the lower section, which are entirely surrounded by the cooling water, surrender their heat to the cooling water, and finally pass off into the air, as indicated at C, at the temperature of the room. The circulating water is supplied at a constant head by means of the overflow device indicated at the left, its temperature being taken by a thermometer, A. It next passes up through the water jacket surrounding the copper cooling tubes, in a direction opposite to that of the hot gases within the tubes, and absorbs heat from the gases. It passes out at the top of the calorimeter, where its temperature is noted by thermometer B, thence to the weighing tank. Water formed by the combustion of hydro-carbons collects from the exhaust gases at the bottom of the combustion chamber, and is strained off through the outlet shewn. The whole cylinder and the top are surrounded by an air jacket to prevent radiation.

In order to determine the heating value of the gas, four quantities are to be ascertained: (1) The number of cubic feet of gas burned; (2) the quantity of cooling water used; (3) the rise in temperature of the cooling water, and (4) the quantity of water condensed from the exhaust gases.

In operating the calorimeter, the cooling water is first allowed to flow through the upper overflow, and then to pass through the calorimeter by opening a regulator near the bottom of the calorimeter. Gas is then turned on at the meter and lighted at the burner. The flow should be such that one cubic foot is burned in from 10 to 15 minutes. The cooling water should be so regulated that its increase of temperature is only 10 to 15 degrees. The thermometers used in the cooling water are graduated to 1/10 degree.



Junker Gas Calorimeter

Readings may be taken after a short preliminary run when satisfactory regulation has been achieved. The meter and the cooling water measurements should be read simultaneously. The temperatures of the entering and leaving water may be taken alternately every half minute.

The heating value, H, of the gas may then be computed from the formula

$$H = \frac{(t_1 - t_2) W}{V}$$

in which t_1 and t_2 are the average temperatures of the cooling water, W is the weight in pounds of the cooling water, and V is the number of cubic feet of gas reduced to standard conditions of temperature and pressure.

The value of H as just obtained is somewhat too large since under practical conditions the water formed by the complete combustion of hydro-carbons in the gas engine is not condensed, but passes off into the exhaust, carrying with it its heat of vaporization. To find the "effective" value of H, the weight of condensed water in pounds is multiplied by 966, and divided by the number of cubic feet of gas. This result is then subtracted from H giving the effective value of the heating power of the gas in British thermal units.

The following determination of H is from a sample test:

Cubic feet of gas, 0.606.

Cubic feet of gas (standard conditions), 0.598.

Number of pounds of cooling water, 15.12.

Temperature of leaving water (average), 69.17 deg. F.

Temperature of entering water (average), 44.17 deg. F.

Temperature of room, 63.14 degrees F.

Number of pounds of condensed water, 0.029.

$$H = \frac{(69.17 - 44.47)\ 15.12}{0.598}$$
$$= 626 \text{ B. T. U.}$$
$$H^1 = 626 - \left(966 \times \frac{0.029}{0.598}\right)$$
$$= 579 \text{ B. T. U.}$$

EPOCHS IN MARINE ENGINEERING.

From paper by Rear-Admiral George W. Melville, U. S. N., before the A. S. M. E. Monthly Meeting, January 31, 1905.

It is interesting to note that the steam log of the *Fulton*, the first American steam man-of-war, for January, 1838, shows that the maximum steam pressure was 11 pounds, the vacuum 24 inches, and the maximum revolutions per minute 18. The *Fulton* was a paddle-wheel steamer. The screw propeller was brought forward for driving large vessels about 1838, although its first successful application was made on a small steamer as early as 1804. It was about 10 years later that the propeller began to come into general use, and entirely displaced the paddle wheel for ocean-going steamers. The reason for this change is largely that on a long ocean voyage the change in displacement is due almost entirely to the consumption of fuel. In the case of the propeller this makes practically no difference in its immersion or its efficiency, while in the case of the paddle wheel the immersion of the floats would be changed, with a diminution of efficiency.

Multiple screws were used as early as our Civil War in some vessels. Twin screws were first used in war vessels where the necessity for keeping the machinery below deck made it more advantageous to apply the power to two shafts. They were much longer in coming into use in the merchant service, but since the era of the swift transatlantic steamers all the very large vessels have been built with twin screws. Triple screws have been used to a considerable extent in the navies of France and Germany, and were included in the design of the fast American cruisers *Columbia* and *Minneapolis*, although this feature has not been repeated in later American design. With the advent of the steam turbine in ships, multiple screws have again come to the front, this time on account of the extremely high speed of rotation of the shafts. Merchant and war vessels, turbine-driven, have been fitted with three and four shafts, with a number of propellers on each.

The introduction of the surface condenser was necessary for the full utilization of the now rising steam pressures, since the jet condenser previously used meant the deposition of a scale on the heating surface of the boilers from the salt water used. With low pressures this did not greatly affect the economy of the boilers, except that on blowing off to keep the density of the water down, a certain loss of heat resulted.

The early boilers in sea-going vessels were of what has been called the box type, that is the boiler was a cubical box with a thin shell, the real strength being given by braces running in three directions. This type was superseded by the cylindrical type which was at first single-ended with two furnaces, but with the introduction of reliable mild steel, sizes were increased and cylindrical boilers to-day have as many as 8 furnaces. Cylindrical boilers continue to be favorites in the merchant marine, with pressures running as high as 220 pounds. The water-tube boiler has, however, made great strides in marine service, and is generally used in the navy.

The object of the water-tube boiler is to reduce weight, give greater safety against explosion, greater rapidity in raising steam, and increase the economy in the generation of steam. In its recent use it dates from about 1880. There are two general classes of water-tube boilers, those with straight tubes of large diameter, say 4 inches, and those with curved tubes of small diameter, from 1 inch to 1½ inches. The large straight tube boilers are not so light as the ones with small tubes, and it is more difficult to secure adequate economy, which is dependent largely upon skillful baffling. They do not permit of such rapid raising of steam as the smaller tube boilers; on the other hand, they permit the replacement of a defective tube and of cleaning the tubes much more readily than the tubes which are bent. As far as safety against explosion is concerned there can be no doubt that there is less danger of an actual disaster affecting the whole ship with the use of water-tube boilers than with the cylindrical type. It has now become the established practice in all navies to use only water-tube boilers in new ships. Our English friends had some trouble with the *Belleville*, but this seems to have been due to some extent to lack of familiarity with it.

The compound engine dates from almost the beginning of steam engineering. Up to the time of the Civil War expansion was practiced to an almost ridiculous extent, although Isherwood's experiments in 1861 demonstrated that with low pressures only a very moderate expansion was permissible. When the pressures had gotten up to about 60 pounds the compound engine began to assert itself. As steam pressures rose, the leaders of the profession became convinced that to secure adequate economy a further stage of expansion was necessary, and this brought about the triple-expansion engine, the credit for which is deservedly given to Dr. A. C. Kirk, of Glasgow. It seemed a logical extension of this idea that with a still further increase of pressure there should be a quadruple-expansion engine, but the advantage as compared with the triple-expansion engine does not seem to be clearly demonstrated.

One can hardly realize to-day what a change came in engineering when the production of mild steel became a commercially reliable matter. The difference between a large wrought iron shaft, such as old Hughey Dougherty used to make at the Morgan Iron Works, and one of the mild steel shafts made at Bethlehem, is as great as could be imagined. I do not possibly see how we could have built engines of the power now common with wrought iron for piston and connecting rods and shafting. The change began in the later seventies, and had become almost complete by the end of the eighties. The use of steel castings in the place of iron castings was made to quite an extent at the same time with a great consequent reduction in weight. The introduction of the new material was of course hampered at first by a lack of knowledge of its particular qualities. About the time that steel began to displace wrought iron, white metal for bearings, and the stronger bronzes also came into use. We may also mention the gradual displacement of copper for piping by steel pipes.

In naval machinery forced draft has been of the greatest possible importance, because it has reduced boiler weights almost one half. It is obvious that if the rate of combustion is increased from 10 pounds of coal per square foot of grate to 40 pounds, there ought to be an attendant increase of heating surface. At about the same time as the reintroduction of forced draft in naval vessels, higher rotational speeds came into use. In the early days 60 or 70 revolutions per minute for an engine of 4,000 or 5,000 horse power was about the limit, but in engines of as much as 8,000 horse power for a single set, one finds the revolutions to-day as high as 130. With increased speed, better material, etc., the production of power for a given weight of machinery has necessarily increased. It is interesting to note that in the *Warrior* of 1861, with 22 pounds of boiler pressure and 54 revolutions, the horse power per ton of machinery was six, while in the *Minneapolis* of 1891, with 165 pounds pressure and 133 revolutions, the horse power per ton is 10.9.

The latest note of progress in marine engineering seems to be the advent of the steam turbine. A number of small vessels of the torpedo boat class have been built with steam turbines, and this has been followed up by their use in a number of excursion steamers, etc., and will shortly be followed by their transatlantic use. The questions of reversal, and economy where both power and speed are reduced, has bothered marine engineers in connection with the installation of steam turbines. In some of the latest practice, the reversing turbines are placed inside the exhaust passages of the ahead turbines so that while the ship is going ahead these turbines revolve idly in an excellent vacuum. When the ship is to be reversed, steam is admitted direct to these turbines and secures the reversal. Regarding economy, it seems hopeless to expect any machinery to work with the same economy at 1-10 power that it does at full power, and it is unreasonable to expect the turbine to do this when the reciprocating engine does not.

LETTERS UPON PRACTICAL SUBJECTS.

SQUARE THREAD TAPS IN SETS.

Editor MACHINERY:

Having seen the letter in the January issue of MACHINERY, "Acme Taps in Sets," with table giving proportions of same, I thought it would be of interest to your readers to also give a table of dimensions for square-thread taps, same being nearly as much used as the Acme form, and still more particular to make. To give the advantage of uniformity for comparison between the former table and this, I have condensed my data, and put in a table of the same general appearance as in the letter referred to.

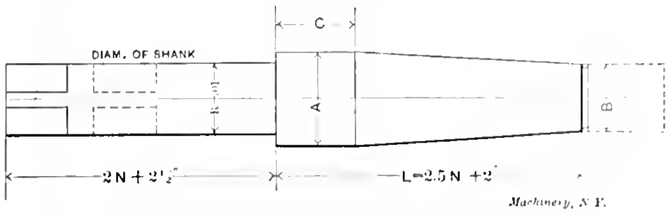


Diagram of Elements of Square Thread Taps in Sets.

ELEMENTS OF SQUARE THREAD TAPS IN SETS.

N = nominal size of tap.
R = root diameter.
T = N − R = 2 (height of thread).

Taper in bottom of thread for about 1 inch from small end in first tap only. Finishing tap should be center-relieved on top of thread.

If first tap is made with pilot, as dotted line shows, add pilot to length of thread, but length over all remains the same.

Length of pilot = .75 × nominal diameter of tap.

No. of Taps in Set.	Tap.	*A*	*B*	*C* expressed in fractions of *L*
2	1st	*R* + .67 *T*	*R*	1/8 to 1/6
	2d	*N*	*A* on 1st tap − .005	1/4 to 3/16
3	1st	*R* + .41 *T*	*R*	1/8 to 1/6
	2d	*R* + .80 *T*	*A* on 1st tap − .005	1/6 to 1/5
	3d	*N*	*A* on 2d tap − .005	1/4 to 3/16
4	1st	*R* + .32 *T*	*R*	1/8
	2d	*R* + .62 *T*	*A* on 1st tap − .005	1/6
	3d	*R* + .90 *T*	*A* on 2d tap − .005	1/5
	4th	*N*	*A* on 3d tap − .005	1/4 to 3/16
5	1st	*R* + .26 *T*	*R*	1/8
	2d	*R* + .50 *T*	*A* on 1st tap − .005	1/8 to 1/6
	3d	*R* + .72 *T*	*A* on 2d tap − .005	1/6
	4th	*R* + .92 *T*	*A* on 3d tap − .005	1/5
	5th	*N*	*A* on 4th tap − .005	1/4 to 3/16

It will be noted that my dimensions, gathered from various sources, conform fairly closely to those given for Acme taps, a result to be expected in so far as both tables are based upon practical experience. There is, however, a decided difference in some respects between square and Acme thread taps, and it will be seen that the work for each tap in a set of square taps is about the same for all of them, the finishing tap excepted. The reason for this is very obvious inasmuch as in a set of square-thread taps each tap is a finishing tap in itself, because the lands of each tap are alike. In a set of Acme taps each tap may be considered as a finishing tap for the preceding one. The last tap in each set has less work to do in order to assure a smooth bottom of the thread in the nut tapped.

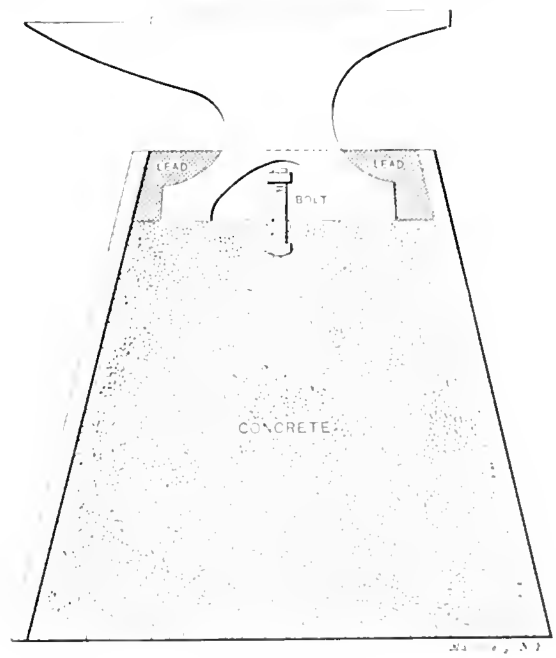
As will be seen from the sketch the first tap is made with a pilot, which is quite important, as it insures a straight-tapped hole in the nut, a result which otherwise is not easily obtained. Dimensions of length in my table are only given as guides, as special conditions will require somewhat different lengths of threaded part and shank. H. D.

IMPROVED ANVIL BLOCK.

Editor MACHINERY:

There is nothing which makes a forge room so untidy in its appearance as anvils carelessly placed on wooden blocks. Even those secured firmly to the blocks by means of straps of iron bolts or staples, in time work loose, shift about and frequently fall off altogether. The anvils and blocks have been a source of annoyance, and an eyesore in the College of the City of New York. To hold the anvil firmly, to have it look neat, and at the same time to make it as noiseless as possible when in use, has been a problem demanding much thought and experience.

As it is desired to use wrought-iron anvils in preference to cast iron, several experiments have been made. The result is that two blocks are now in use in the forge room; one is mounted with a Trenton and one with a Hey & Badden anvil, both being wrought-iron anvils. These are satisfactory in every respect, and the difficulty in holding the anvil secure is solved. All noise and vibrations when the anvil is struck are stopped, and its general appearance is very neat. The anvil is made fast to a mass of concrete, of broken stone and cement encased in a rectangular shaped box 18 inches high made of cast iron 5/8 inch thick, with a base 11 x 18 inches tapering up to 8 x 10 inches at the top, being 1 inch larger, inside measurement, than the base of the anvil. The anvil, as stated, rests upon the concrete 2 inches below the top of the casting. On each side (front and back) of the anvil, embedded in the concrete to a depth of about 3 inches, is a



Improved Anvil Block

bolt and nut, the nut projecting up to nearly the top of casting, and about 1 inch above the concrete. On the top of this concrete melted lead is poured (filling up this space between the base of the anvil and the top of the casting about 2 inches) which flows all around the anvil, the nut of the bolt, and into the corners of the casting. The taper of the casting together with the nut holds the lead to the cement, and this it is evident, holds the anvil firmly.

Several methods have been thought of, such as having the anvil rest on a box of sand, mounted to wooden and concrete blocks by means of bands of iron, hook bolts, staples, etc. All these devices failed to give the result desired. It was found that by placing 1 inch or more of the base of the anvil in a tub of water, it lost its ringing sound, the vibrations ceased altogether, and the sound when struck with a hammer was dead, so to speak, as much so as the so-called noiseless anvils made of cast iron. The base of the anvil rests on the concrete, and is gripped by the lead. This arrangement stopped completely, just as the water did, all vibrations which,

however pleasing they might be to the country blacksmith and to *some* students, are not desired in a college building. The cost of this method of mounting anvils should exceed but little the cost of anvils mounted in the usual way on wooden blocks with straps of iron, etc.

J. H. De Groodt.

New York.

AN EXPANSION CHUCK FOR THE VERTICAL MILL.

Editor Machinery:

The cuts show a chuck for handling a brass-lined gray iron cylinder on the vertical mill. These cylinders, Fig. 1, are bored by a gang cutter and a brass tube is then forced and rolled into them, consequently they vary somewhat in internal diameter. This, together with the brass lining, makes

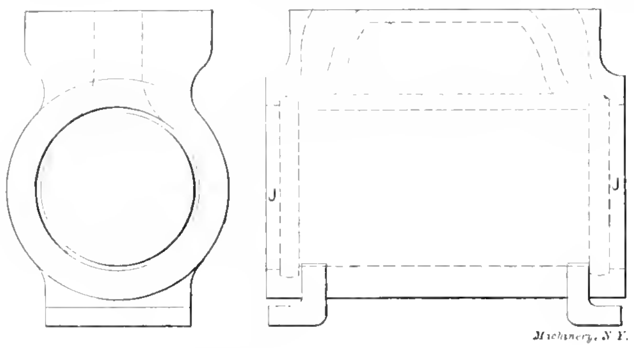
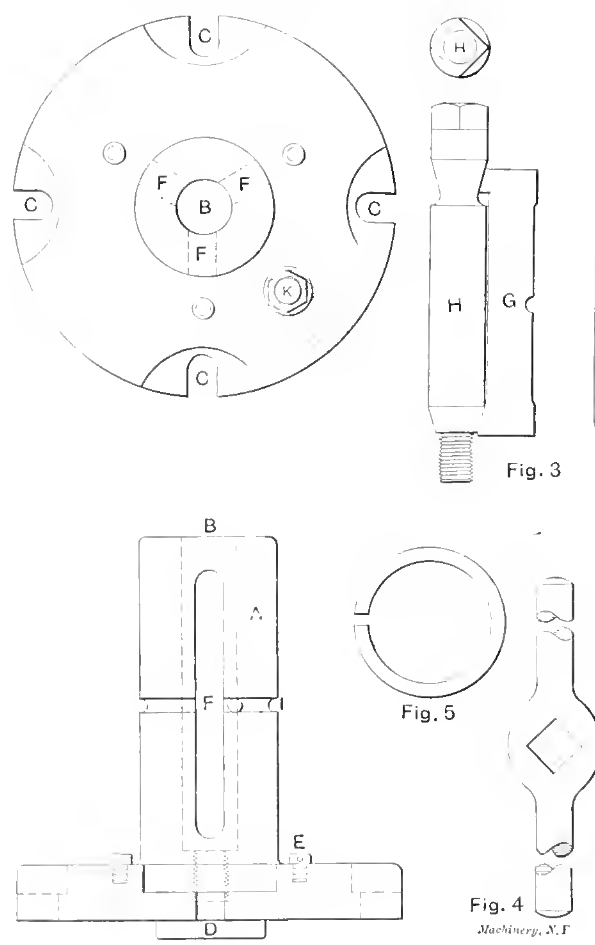


Fig. 1. The Cylinder to be Chucked and Faced.

it impracticable to put them on an ordinary arbor for facing the ends, *J*, of the cylinder, but the chuck shown in Figs. 2, 3 and 5 handles them to perfection.

Fig. 2 shows the chuck body, which is of gray iron, turned at *A* about 7-16-inch smaller than the bore of the cylinder,



Parts of the Chuck.

and bored as at *B*; an 8-pitch thread is cut at the bottom of the bore. The four slots, *C*, are milled into the flange of the body for the bolts which are to clamp the chuck to the machine table. *D* is a boss turned on the under side of the flange to nicely fit a corresponding counterbore in the machine table, and *E* represents one of three hardened pegs for the cylinder to rest on. *F* is one of the three equi-distant slots which are end-milled into the chuck body to receive the jaws shown at *G*, Fig. 3. At *H*, Fig. 3, is shown the center piece, which is made of tool steel, hardened and ground all over to fit nicely in the bore of the body. *H* is tapered at two places, about 25 degrees included angle, threaded at the lower end to fit the thread at the lower end of the bore in the chuck body, and squared on the top to engage with the wrench shown at Fig. 4. The jaws, *G*, Fig. 3, are made of machine steel shaped out on one side to fit the center piece, then placed in the chuck body and turned to size. These jaws are relieved in the center of the outside edge to avoid "bellying" when casehardened. Fig. 5 shows a spring made of drill rod for holding the jaws snugly against the center piece, the jaws having a groove cut in them to receive the spring. The chuck body, Fig. 2, also has a groove cut into it to allow the spring to close in with the jaws, and a pin is driven in at *I* to prevent the spring from turning and getting "straddle" of a jaw. The spring is flattened off on the outside diameter to clear the bore of the cylinder.

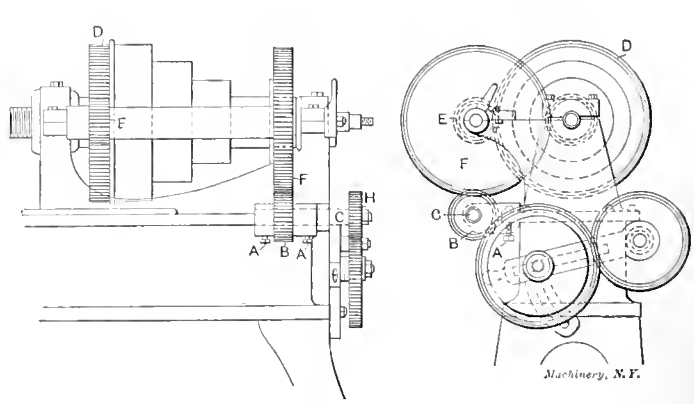
This chuck is practically dust and dirt proof and trues up the cylinders very nicely, regardless of their variation in bore. In fact it works so nicely that we now bore the ends of the cylinders, *J*, Fig. 1, to fit the cylinder heads on the vertical mill instead of making it a special operation on another machine. The operation of the chuck is very simple. To adjust it, screw the center piece down with the wrench until the jaws expand to fit the cylinder. After the cylinder is finished, a turn or two to the left frees the work so that it can be lifted off the machine and another piece placed in position. Of course we do not depend on the jaws to drive the cylinder, but accomplish this with a driver, *K*, Fig. 2, to accommodate which a T-slot is milled in the chuck body.

Uncle Josh.

LATHE GEARING FOR QUICK PITCHES.

Editor Machinery:

The following describes a method of fixing an ordinary, medium-sized engine lathe for cutting coarse-pitch screws or worms. In most shops the change gears are compounded to gain results, but my device consists simply of a bracket which is slipped over the top flange on the lathe bed and is held in place when in use by two screws. The gear *B* is made of the proper size to give the desired number of revolutions to shaft *C* in ratio to the lathe spindle. Suppose, for instance, gear *D* to have 72 teeth; the pinion *E* on the back gear shaft or sleeve to have 18 teeth; and the large gear on the back gear sleeve, *F*, 66 teeth. If it is decided to make the small shaft, *C*, revolve 12 times to one of the lathe spindle, then gear *B* should have 22 teeth. The end of shaft *C* is made to fit the change gears and bring them in line with the gear placed on



Lathe Gearing for Quick Pitches.

the leadscrew. If the leadscrew is ¼ inch lead, or four threads to the inch, and if it is desired to cut a worm of 2 inches lead, one thread to 2 inches, the leadscrew would revolve eight times to one turn of the lathe spindle, while the small shaft, *C*, would revolve 12 times. Hence the ratio of

gears would be 8 to 12, or 2 to 3, so that we could use, say, a 48-tooth gear on the end of shaft C at H, and a 72-tooth gear on the end of the leadscrew. This arrangement allows the use of a fair-sized gear as a driven gear on the screw, and gives more chance for heavy cuts without danger of stripping the gears. It is easy to see that by using an 80-tooth gear on the shaft C and a 40-tooth gear on the screw, the ratio of turns of leadscrew to lathe spindle would be 24 to 1, and a ¼-inch pitch leadscrew would cut 6 inches lead or 1 thread to 6 inches, and still have a fair-sized gear on the screw. I have used this device on a 24-inch swing lathe and cut 3-inch lead worms easily.

J. T.

AN EXPERIMENT WITH GAS.

Carroll Ashley.

Editor MACHINERY:

Oftentimes persons dig for gold and find sand; other times they dig up the unexpected, and find it is better or worse than anticipated. So it is in the experimental room; we start in to develop a mechanical movement perhaps, and before it is finished and even after its functions are found correct, we find it will not exactly do for this or that particular machine, and we lay it aside. Sometimes it is dug up and incorporated into something different. That is how this "experiment" with gas turned out.

When the Cochrane-Bly Machine Works moved into their new shop, they were compelled to bo without gas until 'steen feet of snow could be melted from the earth's surface, so they had to substitute gasoline torch soldering. This was a poor way to do the work, as the flame, though hot enough, was too large, and melted the parts to be soldered before amalgamation took place. We finally decided to make an alcohol burner of the atomizer type.

We had a foot-bellows, which we used in connection with our gas burner, and assuming that alcohol becomes a vapor upon its exposure to the atmosphere, we proceeded to make the apparatus shown in Fig. 1. It consists principally of brass tubing, excepting the nozzle, which was turned to drive into the end of the larger tube—the dotted lines show the appearance of the opening—and a glass bottle at the other end was filled three-fourths full of alcohol. In the smaller tubing

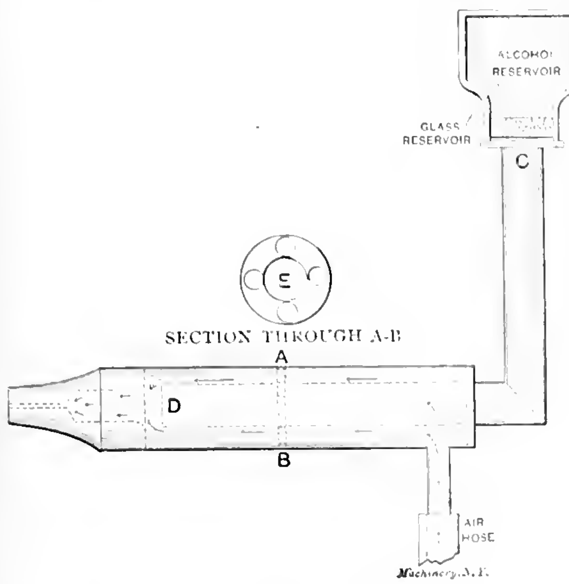


Fig. 1. First Experimental Alcohol Burner

from C to D, waste was packed tight, being freely soaked in alcohol. The piece E had five holes, a large one in the center to support the small tubing equidistant from the walls of the larger tube, and four smaller holes for air passages. This piece was a drive fit and its location in position is shown by dotted lines through the section A B. The air, following the direction of the arrows, was supposed to unite with the alcohol at the end of the small tube at D, Fig. 1, and when forced out the nozzle, was expected to ignite from a match into a "dandy" blue flame.

All being ready, foot power was turned on the bellows and numerous matches were lighted in anticipation of the result. From a spectacular point of view, it was a burning success, though not at first—not until the contents of the reservoir had dripped through into the larger tube; then an overflow

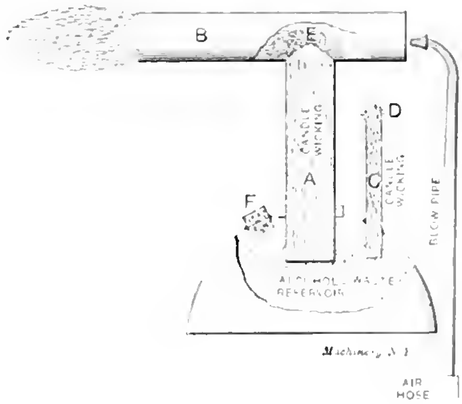


Fig. 2. Final Form of Alcohol Burner

meeting was held and blue flame by the yard expectorated, and I expect that identical experiment ended then and there.

But we decided we could make better fireworks, so we built another burner like Fig. 2. First taking the bottom of an oil can and stuffing it full of waste, the brass tubes A and C were soldered in as shown. Through these tubes candle-wicking was drawn. At the top end of the tube A another tube B was fitted, tube A being driven into an opening at E. At F was a hole fitted with a cork to permit refilling. A blow-pipe soldered in a permanent position, with the small end nearly central to the open end of tube B, served also as a handle to hold the burner. This arrangement of these tubes was not our first attempt at this style of a burner, but after persistent experiment it was found that the form shown in Fig. 2 was the desired article—that is, in so far as it went.

To start this torch the wicking in tube C is lit, its functions being to heat the tube B. The alcohol gathered at E immediately forms a gas which ignites and comes out of both ends of B, but as soon as air is forced into and through the blow-pipe, the flame is emitted from the opposite end from the blow-pipe, in a roaring, very green flame, which is somewhat hotter than that of the gasoline torch. It was no better for our purpose, however, than the gasoline torch, because the flame could not be controlled, that is, focused to a small point. It would be very handy for drawing the temper in broken taps and to my mind is much safer than gasoline. The tubes A and B were ⅝ inch by 5 inches long, and the small tube C was ⅜ inch by 3 inches long, substantially as described.

CARROLL ASHLEY.

Rochester, N. Y.

Carroll Ashley was born in Tallmage, Ohio, June 13, 1871. He received a common school education and took a scientific academical course of three years. He served his apprenticeship with the Noble Sewing Machine Company, Weeping Water, Nebraska, and has worked for the Lozier Mfg. Co., the Snell Cycle Co., the Meilink Mfg. Co., the Toledo Machine and Tool Co., the Tally-Ho Cycle Co., B. F. Bellows, the Eastman Kodak Co., and the Cochrane-Bly Machine Works. Mr. Ashley has done much experimental work and designing, and this is the work which he considers to be his specialty.

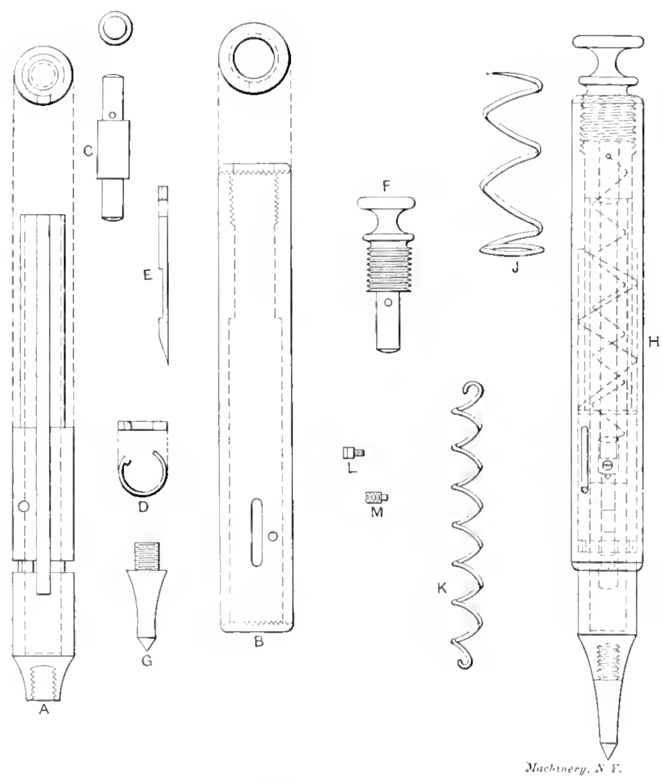
AUTOMATIC PRICK PUNCH WITH ADJUSTMENT.

Editor MACHINERY:

The automatic prick punch recently put upon the market by the Brown & Sharpe Mfg. Co. recalls to my memory one that I made several years ago. From the view of the punch and working parts shown full size in the cut (next page), it will be seen that its construction is in no way similar, and that it has the superior feature of adjustment by which the force of the blow can be regulated.

The parts A and G, when assembled, form the prick punch proper. D is a snap lock made of spring steel, which snaps into the groove on A, allowing the catch at one end to enter the square hole in the bottom of the groove. When the catch enters the hole to its full depth, it engages the hammer, C, as

it passes down in the bore, but E is a wedge fitting in the spline shown in A, the point of which passes under D and acts as a trip by which the hammer is released. The lower point of E is designed to be at all times under the full width of D, the retracting spring, J, preventing it from becoming disengaged. A small screw or pin screws through the sleeve, B, and engages the notch cut in the side of J, by which the latter is moved as the pin strikes the shoulders. The screw or pin holding the wedge must not bind on it, as it only moves about 3-32 inch, while the sleeve moves about 5-16. In operation the point is placed against the work, causing the sleeve to move downward on A. The catch D engages the shoulder of the hammer, C, compressing the small spiral spring, K. As the sleeve nears the lower end of its movement, the pin striking the shoulder of the notch in E pushes it further under D and releases the hammer, allowing the latter to strike the bottom of the hole in which it works, thus punching the work.



Automatic Prick Punch.

The hammer passes the catch freely on its upward movement, since the catch enters the hammer cavity only after the wedge, E, has been moved upward by the upward travel of the sleeve. The force of the blow is adjusted by the adjusting screw, F. In assembling the tool the retracting spring, J, the larger of the spiral springs, is slipped on the small end of A, after which the knurled sleeve, B, is slipped over A, and the two tightly fitting screws shown at L and M are screwed into place.

This tool was not designed to strike a hard blow, but is most useful in working at fine work; if a tool of more power is required it may be obtained by putting in a heavier hammer, or perhaps a stronger trip spring.

New Haven, Conn. OTIS D. STORER.

CHECKING A DRAWING.

Editor MACHINERY:

It may be interesting to your readers to hear of some methods used in checking drawings. In the following I have first given a description of a method in general use, and then described a system I have used, explaining what I think to be its advantages over the usual method.

In checking drawings for a machine, the first thing to be done in all cases is to get the general arrangement, and to check the center distances and elevations with the principal dimensions given on the details. After the principal dimensions on the general drawing have been checked, it is used as a lay-out for the details. Each dimension on the detail is checked, and if a similar detail has been used on some other machine in order to establish a standard the new one should be made proportional to the old. Finish marks are noted on details where required, and none on surfaces that do not need it, for any finish that can be saved lessens the time in the machine shop. Sizes of all bolt holes are marked and the bolts to be used are called for or noted. Every piece on the drawing, either called for or shown, must be given a letter or pattern number, and the number of pieces required for each drawing ordered. If a certain radius for curve is used in one place, the same radius should be used in each similar place. Care must be taken in checking that standard pieces are used as far as possible, especially in slots for bolt heads. If a slot is made so wide that a standard square head bolt turns in it, a special bolt is required; while if the slot had been made narrower a standard bolt from stock would have answered the purpose just as well. Whenever practicable, the pieces of a machine should be made so that one can be removed without disturbing the other, this saving a great deal of time when making repairs. As few patterns as possible should be made and often, with a little foresight, one pattern can be made to answer in two or three places by making some pieces loose so that they can be changed around to suit different conditions. Great care must be exercised that there are no interferences. These can best be detected on the general arrangement and by laying in the adjacent machinery.

In most drawing rooms, when checking, the tracing is used, and all the changes are noted on the tracing with a pencil—blue, red or black, as the draftsman prefers, while the correct figures are checked with ink. After the man who made the drawing has approved the indicated changes the tracer makes them without erasing the pencil marks. The drawing is then returned to the checker, who checks off the changes that have been made. As he checks them off in ink, he cleans the tracing with a sponge rubber and anything the tracer may have missed the checker finds during this operation. All figures on the drawing must be clear, so that there can be no doubt in the shop as to the intended dimensions. The pattern and drawing numbers must be looked up to see if the records have been made out properly and after the detail drawings are all checked the general drawing can be finished. All the pattern numbers are noted and the principal pieces marked with their particular mark and drawing number.

I have checked a great many drawings, however, and find that a much easier and better way is to take a print of the tracing to be checked. All corrections or changes are indicated on this print with red pencil, and all figures that are right are checked with yellow pencil. The changed blueprint is given back to the draftsman and he and the checker go over it and decide which is the correct figure or the better way to do the work. After all changes have been approved, the tracer makes the corrections indicated in red pencil. When this is finished the checker compares the tracing and the blueprint to see if all changes have been made, and if he finds the dimensions on the tracing correspond to the red ones on the print, he checks those on the print with a blue pencil, marks the tracing "checked," and the checked blueprint is filed. If the work does not go together properly in the shop the chief draftsman can produce the checked blueprint, see if the dimensions have been overlooked or improperly checked and so know where to place the blame. When a drawing is checked by this method no check marks show on the tracing, but it is marked in one corner: "Checked by ——," and the date given when checked.

With the first method, it is not unusual for a drop of ink to fall on the tracing or for some of the check marks to be blurred. The checker must then spend quite a little time in cleaning off the drawings, a waste of labor which is obviated by the latter method. If there are a large number of drawings for the machine, the tracings in the first method get very badly soiled and crumpled, it being necessary to have them all on the table during the entire process of checking, which often occupies a week. In the latter method, however, the tracings are out only while the tracer is making the necessary changes and while the checker looks them over to see if they are correct. JULIAN D. PAGE.

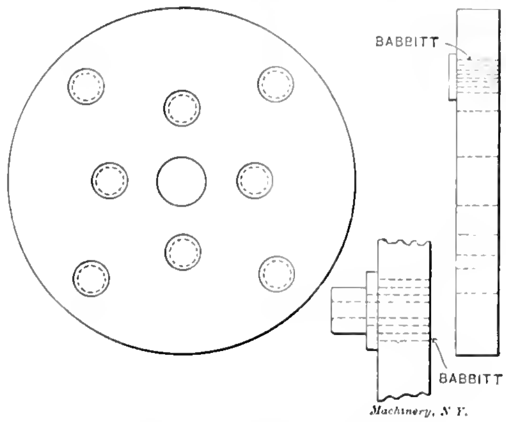
Youngstown, Ohio.

METHOD FOR MAKING DRILL JIGS.

Editor MACHINERY:

I am prompted to describe a method I have for making large ring jigs and other large jigs in general having a large number of holes to be spaced very accurately.

The sketch will give you an idea of what I mean. I take a ring jig as it comes off the boring mill, lay off the holes according to specifications and drill the bushing holes, making them $\frac{3}{8}$ or $\frac{1}{2}$ inch larger than the outside diameter of the bushings. These are made of cast iron or soft steel as the case may be, with a shoulder $\frac{3}{8}$ or $\frac{1}{2}$ inch thick, the shoulder being wide enough to receive two screws and two dowel pins. The hole in each bushing is drilled and reamed to receive the drill, reamer or tap bushings, as usual.



Drill Jig with Bushings fixed in Babbitt.

The bushings being $\frac{3}{8}$ or $\frac{1}{2}$ inch smaller than the holes in the drill jig they can be shifted in any direction. I now place the bushing in the proper holes, approximately in the right place, lay off and drill the screw holes, put in the screws and fasten them. I then rap the bushings to the exact position, finally securing them with the dowel pins. To insure permanent position and solidity of the bushings, the jig can be turned over and the open space around the bushings filled with babbitt.

I have found this method to bring good results; a jig that has a lot of large holes drilled into it is very likely to spring out of shape. I once made a large ring jig containing twenty $3\frac{1}{2}$ and 4-inch holes. After drilling them all, I tested the plate for trueness and found that one side had dropped fully 1-32 inch, so if one was required to be very accurate the jig could, after drilling, again be put on the boring mill and faced true; this would insure all holes being parallel. This method can also be used in altering holes. I once made a jig for a gearbox and through an error in the drawing room, two gears were meshed too close, which by the way was not discovered until the machine was being assembled. I then used this method to correct the error. N. J. W.

"TABLE OF SPUR GEAR TEETH, GIVING DIAMETRAL PITCH": A CORRECTION.

Editor MACHINERY:

I thank you for calling attention to the error in my article on gearing in the December issue of MACHINERY. It occurred in the example given where I carelessly took the speed of the pinion when I should have taken that of the gear; but as the error affects all the work following, I will ask to give a new example.

Example: Suppose we were designing a machine in which a belt wheel, running at 200 R. P. M., is to drive a shaft whose pinion meshes with a gear running at 25 R. P. M., and suppose we know, either by calculation or experiment, that the force or load on one of these gear teeth is 750 pounds. What are the proper dimensions of the gear blanks, and what size pulley should be used, the distance between the shafts being 18 inches?

The velocity ratio is 200 to 25, or 8 to 1. The sum of these ratio terms is 9. The diameter of the gear, on the pitch line, would therefore be $2 \times \frac{8}{9} \times 18 = 32$ inches. Its tooth velocity would be $\dfrac{32 \times 3.14 \times 25}{12} = 209$, say 200 feet per minute. The load we already know to be 750 pounds. Now, from the table, we see at once that the diametral pitch corresponding to the 200-feet velocity and the 750-pound load, is 4; and, in the same square, we observe the horse power to be $4\frac{1}{2}$. The width of the face being "8 divided by the pitch as found" is $\frac{8}{4} = 2$. The outside diameter of the gear blank, by the well-known formula, is 32 plus $\frac{2}{4} = 32\frac{1}{2}$ inches. The pinion blank, by the same reasoning, is $4\frac{1}{2}$ inches diameter by 2 inches, say $2\frac{1}{4}$ inches face. The number of teeth in the wheels are, of course, readily calculated, knowing the diameters and the diametral pitch.

To find the dimensions of the pulley, we have given in the table the H. P.—$4\frac{1}{2}$, as above stated—and we have then simply to apply some belt formula such as H. P. $= \dfrac{D\,R\,W}{2750}$, when, if we choose a 3-inch belt, the diameter of the pulley becomes 20.6, say 20 inches.

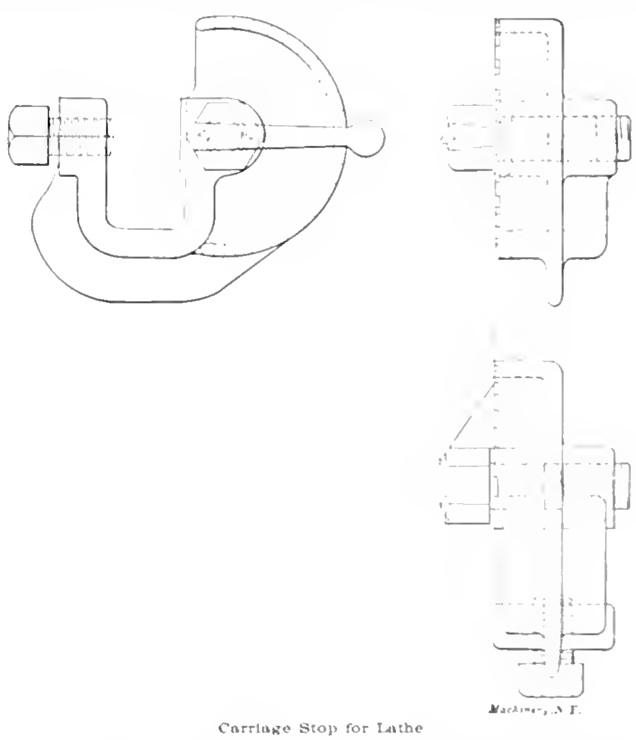
The horse power, as given in the table, is equally convenient in calculating the sizes of the shafts, that is to say, the bores of the gears. The table will be found convenient also in modifying the orginal tooth-face in case it is desirable to use a different pitch from that given in the table, as for instance: When the new pitch can be found in the same horizontal line in which the original pitch is found, that is to say, having the same tooth-speed, it is simply necessary to multiply the tooth-face, corresponding to the original pitch, by the ratio of the two horse powers corresponding to the two pitches (the original horse power being the numerator) and the new face gives a tooth equal in strength to the original tooth. Suppose, in the 32-inch gear, that it were desirable for other reasons to use a 5-pitch instead of the 4-pitch, the original face being 2 inches. The horse power corresponding to the original pitch, 4, is seen in the table to be $4\frac{1}{2}$, and that corresponding to the 5 pitch (in the same horizontal line) is 3; the required face is therefore the original face multiplied by this ratio, or $2 \times \dfrac{4.5}{3} = 3$ inches. This tooth, then, is as strong as the original one 2 inches wide. When the new pitch is found several times in the same horizontal line the average of the corresponding horse powers may be taken.

Worcester, Mass. L. S. BURBANK.

CARRIAGE STOP FOR LATHE.

Editor MACHINERY:

In the article by "Steel" published in the November issue of MACHINERY he describes a lathe carriage stop used in facing up



Carriage Stop for Lathe

piston rings which, while it no doubt answered the purpose very well, would seem to be a makeshift that a shop with an experience of forty-seven years ought not to be content with, the

more so as there are so many jobs where substantially the same method may be used to advantage.

In the sketch I have suggested a plan for making a stop for this purpose which will soon pay for itself in time saved, especially should there be a spell of windy weather when the slips of paper might frequently blow away.

The stop screw is an ordinary ¾-inch hexagon head cap screw with a pitch of 10 threads to the inch so that one-half turn advances it 0.050 inch. By graduating the sector as shown to ten equal divisions a movement of 0.005 inch is obtained so that the finishing cut may be taken of that thickness or any multiple up to 0.050 inch. The spring lever serves to turn the screw easily and affords a positive stop for keeping it in position. J. A. WEBSTER.

Brooklyn, N. Y.

STRIKING UP FORMING DIES.

Editor MACHINERY:

The casual observer seldom thinks of the trouble it is to get the fasteners on gloves, suspenders, etc., finished so that they will act just right when in use. To look at them it seems as though all that is required is to set them any old way, so long as they will hold, but this is far from the truth.

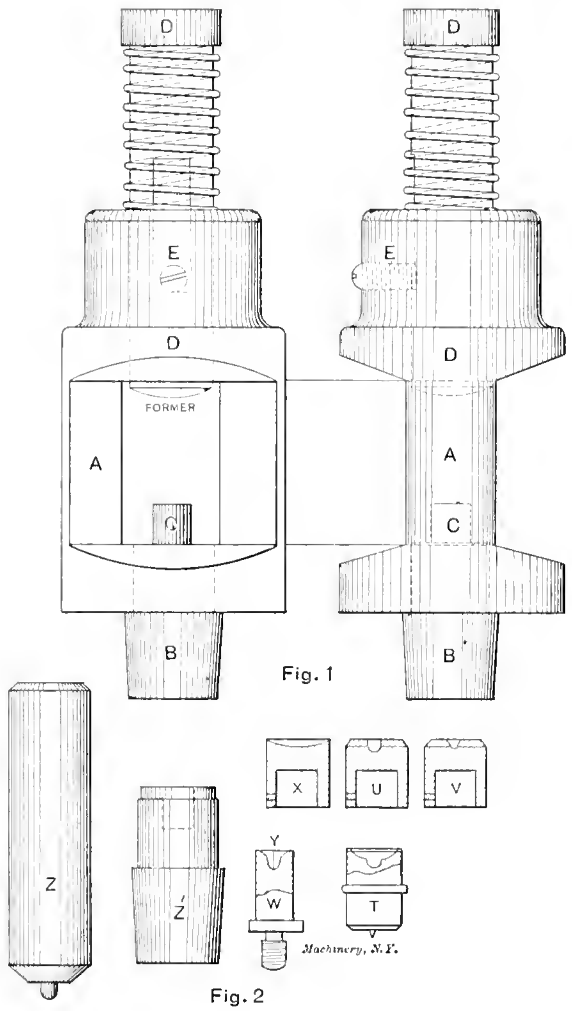


Fig. 2

Striking up Forming Dies.

In applying these fasteners to light, or thin goods, if the dies set them so that they snap hard, the goods soon tear in trying to open them.

Sam was given charge of the making of the setting dies for this work. Now these dies were all made with forming tools and had to be fit to gages; and were polished with emery cloth afterward by apprentices. It frequently happened that the boys held the emery cloth too long on some of the dies and when they were put in use, this made so much variation in the work turned out as to cause trouble.

Sam became tired of this and adopted a scheme that stopped all trouble from this source. Fig. 1 shows what you might call a small forming press or sub-press. This was used under a drop, which was controlled by the foot. *A* is the body of the forming press. *B* is a taper plug which fits tight in *A*, the taper end fitting in the anvil of the drop. *C* engages the die when being struck up by the hob *D*. A die similar to *X*, or any of that class, Fig. 2, is placed on the stud, *C*; the drop is then raised to the height required and dropped on *D*, which descends on the die and produces an exact shape. The spring raises the hob *D* so that the finished die can be removed and another inserted. The screw *E* stops *D* at the proper height. In striking up a die like *W* the parts *Z*, *Z'* are used. The blow required to form *W* is so slight that it was not necessary to use the drop. A plain hole was drilled at *Y* and a light hand hammer was all that was necessary. With a slight experience the right blow can be easily gaged, so that the dies all came out alike. Of course different hobs were made to suit the various shapes, a few of which are shown in Fig. 2. PEDRO RE.

MILLING A LARGE SCREW.

Editor MACHINERY:

One afternoon while wandering through the machine shop connected with our plant, the Atlas Portland Cement Co., Northampton, Pa., I came across a job that made a great impression on me. On the floor lay several screws 14 feet long and 6 inches in diameter, with a lead of 6⅝ inches. In a 48-inch Fitchburg lathe beside them another was being milled out with two cuts at a rate that filled me with astonishment. Almost any draftsman could design a machine for doing this work if given time and money enough, but the master mechanic of this shop, Mr. Robert McClellan, in addition to keeping a very large plant in repair and building a good deal of special machinery for two other plants under construction, had devised the rig for doing this job from material found in an ordinary repair shop. Scarcely a part used had been made new, and the ingenuity shown in getting it together deserves the greatest credit.

At three corners of the lathe carriage were erected pieces of "two by four" and at the fourth corner a structural angle was used for some reason which I have forgotten. Across these uprights other pieces of joist were laid and well braced, and on these a countershaft was mounted. A 5-horse-power motor was placed at the rear of the carriage and belted to the countershaft. The regular tool block was removed and the head from a vertical milling machine substituted. This carried an end mill which could be adjusted up and down, and fed in and out by the regular cross-screw in the carriage. The mill was driven by a belt from the countershaft, a suitable belt-tightener being provided. The regular traverse rest was used but a jackscrew was placed between the carriage and one of the jaws for taking the downward thrust.

The lathe was geared up to give the right lead, the triple back gears were thrown in and the belt thrown onto the largest sheave of the cone pulley. The current was now turned on, the mill fed in to the right depth, the lathe started up, and the job commenced. The thread was of about 1¼ inches cross-section with large fillets at the bottom. Two cuts only were taken to remove all the stock, since, for the work the screws had to do, it was not found necessary to remove the scale from the outside of the bar. If I remember rightly, the speed of the cutter was 40 feet per minute, its diameter being about 2½ inches. It made 60 revolutions per minute. The rate of feed was about 1¾ inches per minute, and the depth of cut about 1¼ inches, less than a day being required to finish a screw.

Rutland, Mass. H. A. HOUGHTON.

METHOD FOR BURNISHING BALL CASES ON INTERNAL BEARINGS.

Editor MACHINERY:

The writer, knowing the ever-increasing tendency of manufacturers to adopt the ball bearing ideas on their machines and products, is now giving what his experience in such matters has shown him to be successful, the methods described in the following having been adopted and used on many thousand machines. The originality of the system he feels to be his own, and the superiority over the old system of shaving ball cases with a single blade is without question. In making

ball cases I have found that in the "cupping-out" process, it was almost impossible to get as smooth a cut as desired by the single blade method, and after several attempts to overcome the crude conditions, the methods as explained in this article were adopted. I have found it hard to hold the case when

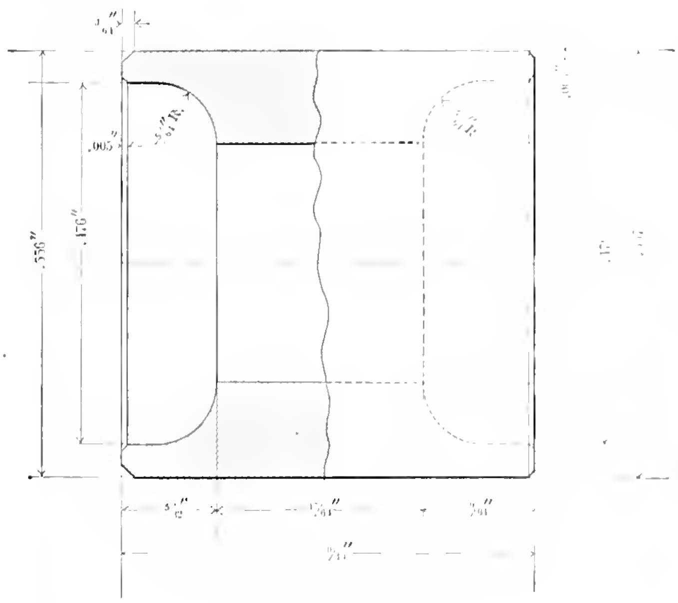


Fig. 1. Ball Case, Enlarged.

desirous of cutting to size, and especially was it so when a "cup-out" at each end was wanted to get the two diameters to run true with the hole in the case, or with the outside diameter as shown in Fig. 1. This method is as follows:

Drill and ream hole of case, and cut off to length on automatic screw machine; then place the case in a spring chuck in a

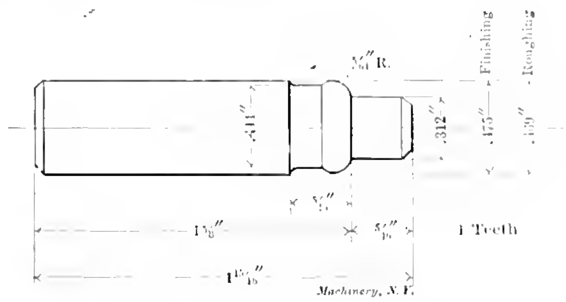


Fig. 2. Roughing and Finishing Counterbores

hand screw machine for cupping. The tools necessary for the process of cupping and burnishing consist of roughing counterbore, finishing counterbore, and burnishing tool. The roughing and finishing counterbores each have a tit on them to fit the 5-16-inch hole in the ball case. These are used in a floating holder, to float with hole in case, and are made as shown in Fig. 2.

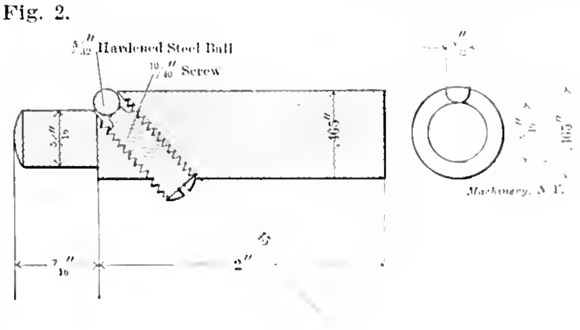


Fig 3. Burnishing Tool.

After roughing, the finishing counterbore is used, which is made to cut 0.00025 inch undersize; by that I mean for the cupped hole to be that much smaller for the burnishing tool to burnish. This tool is shown in Fig. 3. It also has a tit which fits the 5-16-inch hole in case, and is used in a floating holder. The ball in the burnishing tool should be the same radius as the ball race, or a little over-size.

Some of the readers of this article will probably think that when the ball case is finished to size and hardened it might be out of true. The Underwood Typewriter Co. has over forty thousand such ball cases on their machines, and the writer has not had one-half dozen defective, even these being ground to size on the outside diameter of case for required fit to casting into which they are placed. When the ball case is assembled there can be no end shake or side play, notwithstanding that there is but 0.003 inch limit for depth from outside, so that the reader can readily see that the work has to be done somewhere near right. It is obvious that the old way of hardening and grinding would be very costly, when compared with the method which is used as described above.

P. STERN.

Hartford, Conn. Underwood Typewriter Co.

SOME ENGLISH INSERTED CUTTER TOOLS.

John C. Hafner

Editor MACHINERY:

Fig. 1 shows an inserted tooth-milling cutter which has given very satisfactory results. This was originally made in a great hurry for facing the bottom of pedestals, but it is now used for a variety of rough work. It is 15 inches in diameter and has sixteen 3/4-inch diameter high-speed steel cutters, each held in position by a 1/2-inch diameter square-headed screw and adjusted by a grub screw from the back. The body, which is light but plenty strong enough, is made of cast iron and is threaded to suit the spindle nose of the milling machine. It is simple and inexpensive to make, and the idea will, I think, be plainly seen from the sketch without the need of further description.

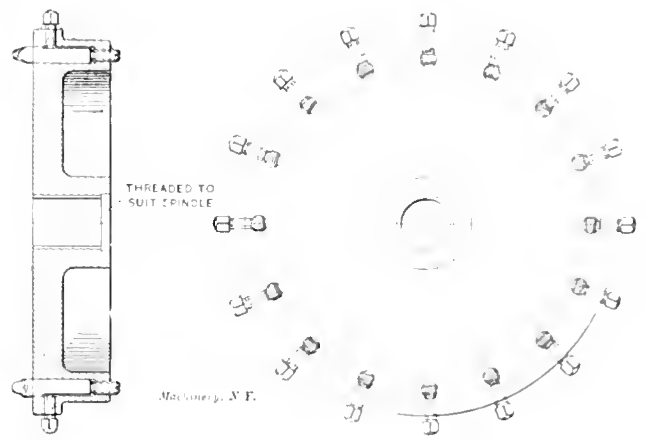
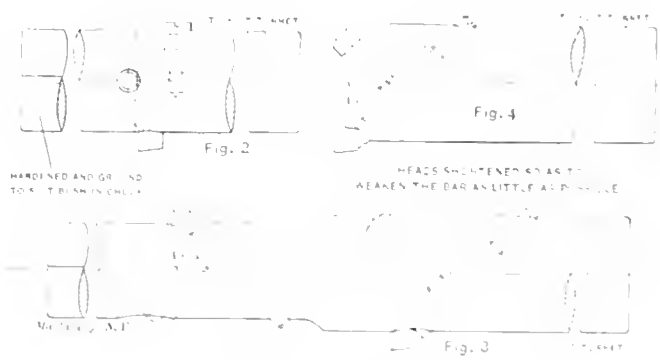


Fig 1 Inserted Cutter Mill

It is the usual procedure when boring castings, etc., in the turret lathe to rough the holes out with a single-point boring bar and to finish them with a bar having a flat cutter. If greater accuracy is required, a reamer is put through, an adjustable floating reamer giving very good results. The tools used for this operation, of course, depend upon the diameter



Inserted Cutter Boring Tools

JOHN C. HAFNER was born at Lincoln, England, March 5, 1882. He attended evening classes for five years at the Technical School and the School of Art. He served an apprenticeship (not articled) with Allday & Onions, Birmingham. After serving his apprenticeship he worked for Charles Taylor & Co., Alfred Herbert & Co., and Vickers Sons & Maxim. He is a draftsman, designing small tools, jigs and fixtures.

of the hole being bored. The majority of single-point boring bars that I have come across, however, have no means for adjusting the cutters. The most common type appears to be the one in which the cutter is held in position by a hardened pin driven into the bar at right angles to the axis of the cutter and bearing upon it. Fig. 2 shows a bar of this type, but with a screw for adjustment, the head fitting into a notch in the cutter. Whenever possible, I try to avoid holding these cutters in position by means of pins driven in, for the cutters require frequent grinding, which necessitates removing them from the

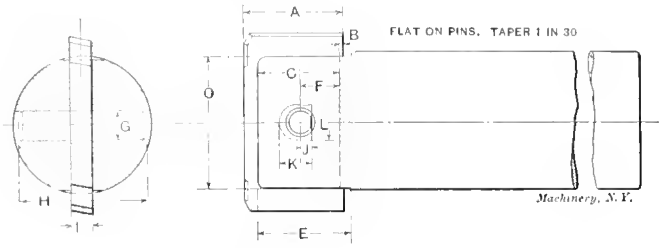


Fig. 5. Inserted Cutter-bar for "Blind" Holes.

bar, and this knocking in and out always seems to me an unsatisfactory business. There can be no doubt that when the cutters are not adjustable much time is lost in resetting. Fig. 3 shows a bar in which the cutters can be quickly removed by simply slackening the square-headed screw; or for small bars, a grub screw may be used, which is sufficient to hold the cutter firmly in position. To obtain good results, it is best, especially where boring long holes, to support the front end of the bar, preferably in a hardened steel bush held in the chuck. It is not always possible to support the bar, however, since the holes being bored do not always go right through the piece, and for such "blind" holes the bar shown in Fig. 4 answers all

LIST OF STANDARD BORING BARS.

Diam. of Bar.	A	B	C	D	E	F	G	H	I	J	K	L
3"	1 7/8"	1/16"	1 5/8"	2 7/8"	1 3/4"	3/4"	9/16"	2 3/4"	1/2"	1/8"	5/8"	1 9/32"
2 3/4"	1 3/4"	1/16"	1 1/2"	2 5/8"	1 5/8"	11/16"	1/2"	2 1/2"	7/16"	1/8"	9/16"	1 7/32"
2 1/2"	1 5/8"	1/16"	1 3/8"	2 3/8"	1 1/2"	11/16"	1/2"	2 1/4"	3/8"	1/8"	9/16"	1 7/32"
2 1/4"	1 1/2"	1/16"	1 1/4"	2 1/8"	1 3/8"	5/8"	7/16"	2"	3/8"	1/8"	1/2"	1 5/32"
2"	1 1/2"	1/16"	1 1/4"	1 7/8"	1 3/8"	5/8"	7/16"	1 7/8"	3/8"	1/8"	1/2"	1 5/32"
1 3/4"	1 3/8"	1/16"	1 1/8"	1 5/8"	1 1/4"	9/16"	3/8"	1 5/8"	5/16"	3/32"	7/16"	1 5/32"
1 1/2"	1 1/4"	1/16"	1 1/8"	1 3/8"	1 1/4"	9/16"	5/16"	1 3/8"	5/16"	3/32"	3/8"	1 1/32"
1 3/8"	1 1/4"	1/16"	1 1/16"	1 5/16"	1 3/16"	17/32"	5/16"	1 1/4"	1/4"	3/32"	3/8"	1 1/32"
1 1/4"	1 1/8"	1/16"	15/16"	1 3/16"	1 1/16"	15/32"	1/4"	1 1/8"	1/4"	3/32"	5/16"	9/32"
1 1/8"	1"	1/16"	13/16"	1 1/16"	15/16"	13/32"	1/4"	1"	1/4"	3/32"	5/16"	9/32"
1"	7/8"	1/16"	11/16"	15/16"	13/16"	11/32"	1/4"	7/8"	1/4"	3/32"	5/16"	9/32"

right. The cutter is held in position and adjusted in the same way as in Fig. 3, and with this bar a hole can be bored up to a shoulder, since the cutter projects beyond the end of the bar. Fig. 5 shows a bar with a flat cutter for finishing blind holes, and the table gives a standard list of sizes of this bar from 1 inch to 3 inches diameter. These cutters are held in position by the usual hardened parallel pins with taper flats on them. A hole is drilled in the cutter a little larger in diameter than that of the pin, one side being squared out and tapered to correspond with the taper on the pins.

Sheffield, England. JOHN C. HAFNER.

TRIANGLE FOR ISOMETRIC DRAWING.

Editor MACHINERY:

I send sketch of an appliance which will be found of use to those who have much isometric drawing to do, as for patent drawings. It consists of a triangle, Fig. 1, having two angles of 30 degrees each, and out of which is cut an equilateral triangle, one side of which is parallel to the long side of the piece. This device is kept on the upper edge of the T-square blade, and does not need to be turned over, but only slid to right or left, to make lines 30 degrees or 60 degrees from the horizontal, either to right or to left. If, furthermore, there are two sets of graduations, of which those of one set are 9-11 (more exactly, 89-109 or 1,000-1,225; or, still more exactly, 0.8165), those of the other set, the shorter divisions, serve to measure distances in the three main axial directions, as for instance the foreshortened lines, *AB*, *BC*, *CD*, *DE*, *EF*, *AF*, *AO*, *CO*, and *EO*, of Fig. 2, while the long ones serve for unforeshortened ones, such as *AC*, *AE*, *CE*, *BD*, *DF*, *BF*.

Further, the plan and elevation of objects the sides of which are isometrically drawn, may be constructed from the isometric projections by drawing on the larger scale at the 90-degree angles in plan or elevation, lines which are at the 60-degree angle in the isometric projections. Thus the plan, or elevation of the cube shown in Fig. 2, is given in Fig. 3, on the same scale; the line *AO'*, *AF*, etc., being 1.225 as long as in Fig. 2.

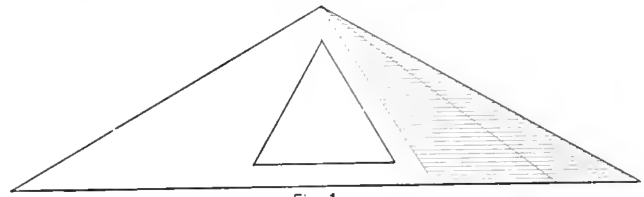


Fig. 1

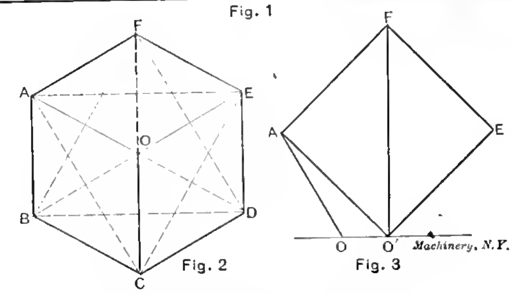


Fig. 2 Fig. 3

Triangle for Isometric Drawing.

If the edge of the triangle has three scales bearing the relations 707, 1000 and 1225, the first gives the minor and the third the major axis of ellipses representing circles drawn according to the second, and the latter two serve as above mentioned.

Hanover, Germany. ROBERT GRIMSHAW.

THREE-PIECE ELLIPSOGRAPH: A CRITICISM.

Editor MACHINERY:

In the November, 1904, issue of MACHINERY, Mr. J. D. Adams explains how to make an ellipsograph, but to my thinking the directions and diagrams are not complete. He says nothing whatever about the slots for the center screw to move in, but merely: "The whole apparatus is held together by a large wood screw passing through Figs. 2 and 3 into the center of Fig. 1," etc. Now, if this screw is screwed in tightly, Fig. 3 cannot move, or in other words, the screw cannot move in the

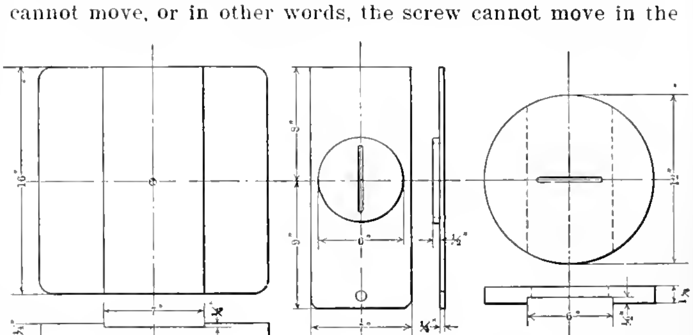


Fig. 1. Fig. 2. Fig. 3.

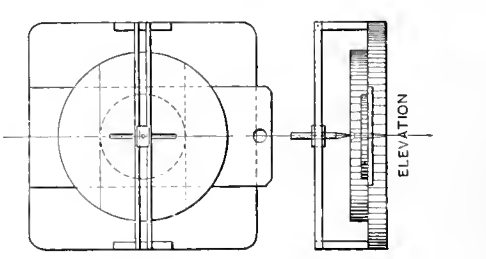
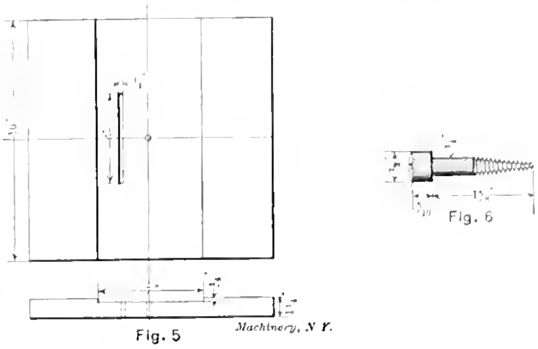


Fig. 4.

Three-piece Ellipsograph.

slot of Fig. 3, which movement is necessary to produce the ellipse. There are, however, two very simple and easy ways by which the desired result can be accomplished. One is by using the pieces as he has shown, except that there must be a slot in Fig. 1 as in Fig. 5. Fig. 2 can then be adjusted to the desired distance from the center, and fastened to Fig. 1 from the under side through this slot. The screw can then be left loose through Fig. 3 so that it can have the desired movement. A still better plan, however, would be to use

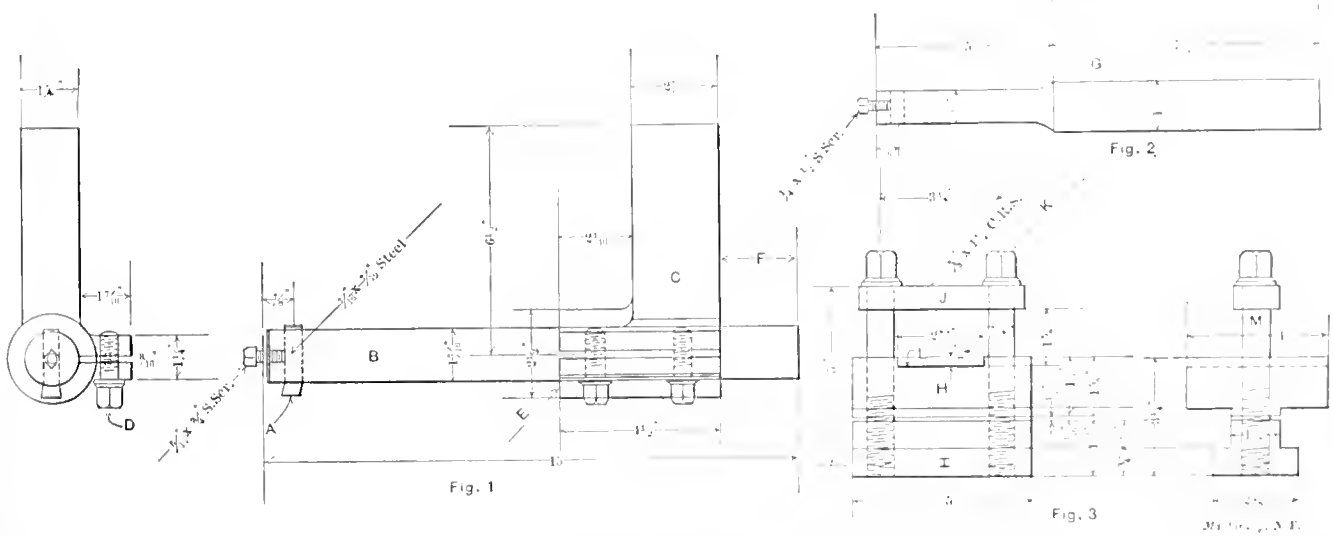
but the one screw, making some modifications in its shape and application. If the screw were made as in Fig. 6, that is, an ordinary wood screw with a filister head, and the slot in Fig. 2 made to fit the body of the screw, and the slot in Fig. 3



Improvement in Three-piece Ellipsograph.

to fit the head, then Figs. 2 and 1 could be joined solidly and still leave Fig. 3 free to rotate and slide along the head of the screw. In making this ellipsograph, I would make the slot for the screw head in Fig. 3 only part way through on the under side, so as to leave the top surface free from holes, otherwise the slot will prevent the cutting of small ellipses. In using this device, the top circular plate should be lifted off and Fig. 2 moved the distance off center required for the radius of the larger diameter of the ellipse. The screw should then be tightened and the top plate put on, when the pencil can be moved the distance off center required for the radius of the smaller diameter. CHARLES G. TAYLOR.

Hartford, Conn.



Planer and Lathe Cutter and Boring Bar.

PLANER AND LATHE CUTTER AND BORING BAR

Editor MACHINERY:

The cuts show a combination inserted cutter tool which I made and found to be very efficient in the work for which it is adapted. Fig. 1 shows the tool as first constructed for cutting keyways, through long hubs, in the planer. The bar *B* is a piece of 1 7-16-inch cold rolled shafting fitted with a square hole and setscrew to hold cutter *A* as shown. The cutter bar holder *C* is a forging, bored a close fit for bar *B* and finished with the face *E* slightly in advance of the tool holding studs in clapper-box. The shank was planed all around to just fill space for tools under tool clamps, with the nuts full on studs. Screws *D* were fitted to any convenient wrench. With this bar the heaviest cuts could be taken with perfect rigidity, and the planer which was a 24-inch by 24-inch by 6-foot machine of modern make was stalled without any indication of springing or slipping of the bar. The extension *F*, under cross-rail, if properly set, prevented raising bar high enough to strike tops of holes. Fig. 2 shows another cutter bar, *G*, made to be used in small bores.

Fig. 3 shows a block which was so constructed that the tool shown in Fig. 1 could be used as a boring tool for a 24-inch Blaisdell lathe, and it needs very little explanation. The raising block *H* has a groove in the top, of the proper width to just fit the shank of *C*. A tongue on the bottom was fitted to the toolpost groove in the lathe cross-slide. The face *L* was just high enough to hold the center of bar *B* in line with lathe centers. *I* was a loose fit in bottom of toolpost slot and was tapped for the screws *K*, the heads of which were fitted to the toolpost wrench. *J* was made of a piece of $1\frac{1}{4}$ x $\frac{5}{8}$-inch cold rolled steel. A pair of light springs (not shown) were slipped over screws *K* at *M* to hold up clamp *J*.

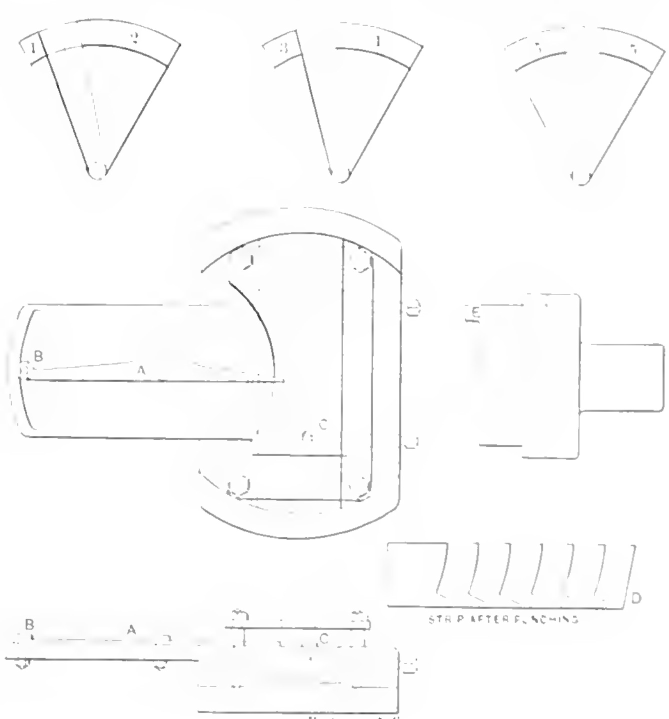
With this rig in the lathe, I have bored 3-inch holes, which were cored $2\frac{3}{4}$ inches, with the cut at times almost all on one side, and had good holes with one cut; but for accurate work, of course, a very light finishing cut was necessary. The use in the lathe was not a part of the original idea, but withal the whole rig when completed was well worth the money it cost to the small shop in which it was used.

A. B. C.

PUNCH AND DIE, ADJUSTABLE, TO CUT SECTORS OF VARIOUS LENGTHS.

Editor MACHINERY:

I send you a sketch and description of a punch and die with an adjustable gage for producing the brass contact sectors for electrical controlling apparatus (principally crane controllers). By this method it is necessary to have only



Adjustable Punch and Die for Cutting Sectors

one die for sectors of the same radius instead of the five or six separate dies which are usually required. It is possible that in the course of a short time this particular type of controller may become obsolete and it will, therefore, be seen how essential it is to manufacture it with the least possible outlay for tools.

The die was made somewhat larger than the largest sector to be punched and was fastened to the cast-iron bolster in the conventional way. A flat piece of machine steel which holds the adjustable gage *A* was recessed into one side of the bolster and fastened with filister-head screws. The gage itself was made to swivel about a central stud and is clamped in position by a binding bolt and nut *B* at the outer end. In the sketch the gage is shown in position to punch sector No. 5. The eccentric stop disk *C* which is held down by a flat-head screw gives the required variation in the distance between each successive punching. The thickness of the stock to be punched (1/4-inch hard sheet brass) made it desirable to have the stripper plate as rigid as possible. It is held in place by the four studs and nuts as shown.

To prevent shearing on the punch or die, the back end of the punch, *E*, was allowed to enter the die before the actual punching takes place. The strip to be punched having been cut the desired width and slightly beveled on the end, as shown at *D*, was held against the stop disk and fed along in the usual way, care being taken to keep it close up against the gage. When the gage is adjusted to its extreme position the bolster may be swung around to bring the gage in the same relative position with regard to the bed of the press which it occupies in the sketch, thus enabling the operator to feed the strip straight across instead of on an angle.

New York. H. J. BACHMANN.

* * *

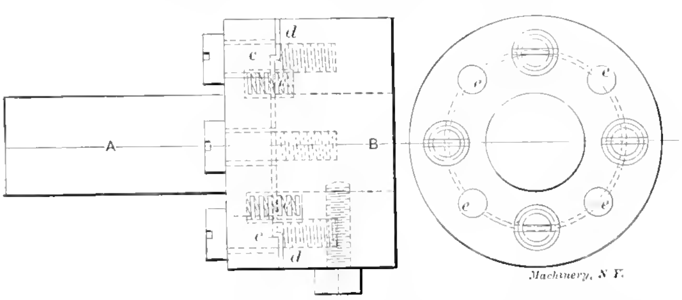
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

SELF-ALIGNING HOLDER FOR SCREW MACHINE.

The cut shows a self-aligning holder for a screw machine which has proved very satisfactory in my experience. *A* is the holder shank, and *B* is the holder for the tool. *A* is counterbored at *c*, and *B* is made with a shoulder at *d* to fit loosely in *c*. The difference in size of *c* and *d* depends upon the amount of side movement required. *A* and *B* are held together by four screws which have the same amount of clear-

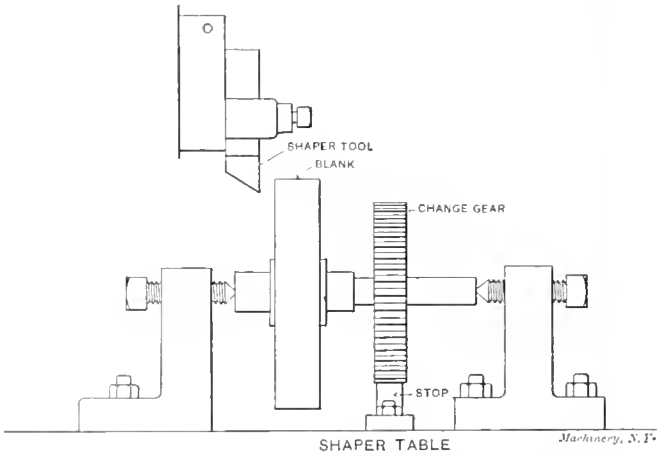


ance in *A* as given at *c-d*. Four holes are drilled at *e* to hold spiral springs, which counterbalance the thrust of the reamer or other tool held in the holder. It will be seen from the construction that no matter in what direction movement is required for alignment, it may be obtained, and at the same time the tool is held from turning.

Roxbury, Mass. C. M. DALL.

SIMPLE GEAR CUTTING DEVICE.

Several years ago I worked in a repair shop which had no universal milling machine or index centers that could be used on the planer or shaper. Consequently we were in pretty bad shape when it came to the matter of making new gears, which fortunately we seldom had to do. When such a job could not be escaped the foreman rigged up the primitive device shown in the sketch, which worked fairly well, although the product would scarcely have passed a critical shop inspector armed with micrometer measuring tools. The device consisted of two angle plates, clamped to a shaper table, and having two holes tapped through the upper ends for the pointed setscrews. These played the part of centers for supporting the mandrel carrying the blank and a lathe change gear having the same number of teeth as were to be cut in the blank. The stop was clamped to the table and fitted closely in the tooth

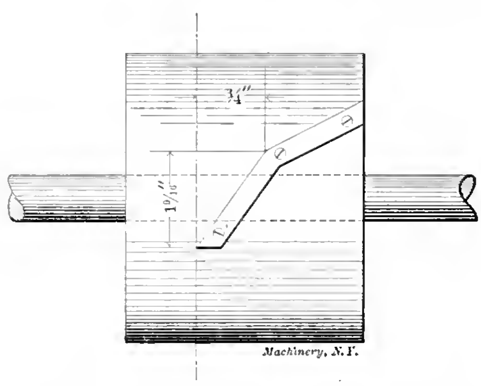


spaces of the change gear. The blank was "indexed" by loosening one of the centers, lifting the change gear out of engagement with the stop and turning it one space. By roughing out the blank and then going over it with a finishing tool a pretty fair gear could be made, but it took a lot of time.

R. E. DERF.

CAMMING SCREW MACHINES FOR THREAD CUTTING.

In the first place I figure the number of revolutions the drum turns per minute. For example, the line shaft makes 180 revolutions per minute and drives from 14-inch pulley to an 8-inch on the countershaft. Applying the usual formula, we have $180 \times 14 \div 8 = 315$ revolutions of the countershaft. A 5.8-inch pulley on the countershaft drives a 12-inch on the wormshaft, which will run 152.2 revolutions per minute. We may drop the fraction. The wormwheel has 150 teeth, which, with a single pitch worm gives: $152 \div 150 = 1\ 1\text{-}75$ turn of the drum per minute. The drum is 15 inches in diameter, and its circumference is $15 \times 3.1416 = 47$ inches. In 1 1-75 turn a point on the drum will move $47 \times 1\ 1\text{-}75 =$ 47⅝ inches, nearly. Then I figure the speed of the stock. For example: A 10-inch pulley on the countershaft at 315



revolutions per minute driving a 7-inch on the spindle of the screw machine, gives $315 \times 10 \div 7 = 450$ revolutions of stock per minute.

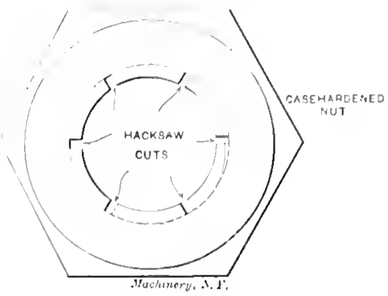
Now as we cut one thread for each revolution of the work, if we wish to cut a 20-pitch thread ¾ inch long, it will take $20 \div ¾ = 15$ threads = 15 turns. Now to find how far the drum will travel for each 15 revolutions of the stock we have: 15-450 = 1-30 of a turn of the drum, which is 47⅝ ÷ 30 = 1.58, or .018 inch more than 1 9-16 inches. We must then lay out the cam to give ¾-inch longitudinal motion to the cam roller while the drum rotates a distance equal to 1 9-16 inches, as shown in the accompanying sketch. The cam plate should be made somewhat longer than the exact layout calls for, to allow the roller to pass the heel and engage the angle positively before the tool enters the work.

G. H.

Dayton, O.

TO STRAIGHTEN BRUISED THREADS.

A little trick worth knowing in repair work is the use of casehardened nuts for straightening bruised threads. It frequently happens that in dismantling a machine some of the bolt threads are jammed so the nuts cannot be started again when it comes to the matter of assembling. If hand dies are available such threads may be readily repaired, as a general thing, but it sometimes occurs that a bolt or stud is so located that an ordinary hand die cannot be used without removing it, and this may mean a lot of extra work, to say nothing of

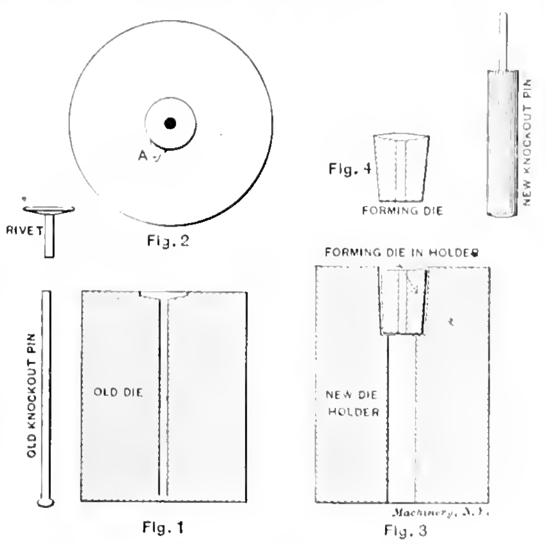


the delay. If the thread is only slightly jammed a casehardened nut of the same size and lead screwed on, will generally correct matters so the regular nut will go on without trouble. If the damage is more serious it may be necessary to convert the nut into an improvised solid die, which can be done with little work. Anneal the nut, and with a hacksaw, working through the nut, cut slots in the thread, as shown in the sketch. Then harden the nut and you have your die. Of course the bruised thread must be filed down so the nut can start, and you must expect it to do but little actual cutting.

R. E. Derr.

A SMALL CHANGE THAT MADE A BIG IMPROVEMENT IN THE OUTPUT OF A MACHINE.

I am toolmaker with a manufacturing company which makes an automatic button requiring a stud or rivet composed of copper, and of the form shown in the cut. These studs were formerly supplied by an eastern firm, and were a big item in the cost of producing the buttons. It was finally decided to purchase a rivet-making machine to manufacture the rivets at home. The first obstacle to overcome was that the maker of the machine was averse to selling one to my firm, claiming that it would never pay, and that we would be unable to find



anyone who could keep the machine in operation. Notwithstanding this discouragement, the machine was purchased at an outlay of something like $1,200. It was then "up to me" to make the machine work and to reduce the cost of the product. We were able to make the machine work successfully, but soon found that the die was an expensive piece to keep in good repair. It was 1½ inches diameter by 1¾ inches long, while the rivet stem diameter was only 0.090 by ¼ inch length, with a head ⅜ inch diameter and 0.017 inch thick. My principal trouble was the uncertainty in tempering the dies. They generally gave trouble by breaking out as shown in Fig. 2 at A, after which the die was a total loss. I finally decided to do away with the large die, making a die-holder of the same dimensions as the original die. The die-holder was made of cast steel, tempered, and was ground out to a taper of 0.010 in ½ inch of length, so as to secure a good driving fit for the die. The small forming die was made as shown in Fig. 4 to fit in the holder with its upper face 0.015 below the surface. The knockout hole was enlarged to admit a pin strong enough to knock out a die when one had to be removed. With this construction the die and die-holder are practically one so far as the operation of the machine is concerned, but when the die has to be renewed, I only have to handle a small piece of steel which is hardened and tempered with much less risk than the former large die. The dies are made of drill rod, hardened and ground to fit. The saving in work and material has reduced the cost of production one-third. I have had some of the new dies running eight days of ten hours each, making in all 493 pounds of rivets, or better than the maker's daily production by nearly 200 pounds.

Hermann G. Krueger.

Louisville, Ky.

[It seems scarcely fair for our correspondent to assume that the change in the die should be altogether credited with the surprising increase in output, for a solid die should give an equal output so long as it remains in good shape. But the principle is one that can be profitably employed in many places, and in this connection it is worth noting how often the success or failure of a machine depends upon the design of a small part.—Editor.]

CIVILIZED, THOUGH SAVAGE.

We have come into possession of the following unique business card of a western machine shop, which speaks for itself. While 'tis said that "music hath charms to soothe e'en the savage breast," no one who knows the feeling can deny that the whir of the emery wheel and the squeak of the planer belt, are more cheering to the traveling journeyman looking

STANLEY SAVAGE — O. W. SAVAGE

SAVAGE BROS.

"Civilized" Machinists

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Patents Designed and Manufactured
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All Kinds of Tool and Novelty Work

DENVER, COLO.

for a job than the most entrancing operas ever sung. Where the machine shop exists there is a marker of civilization, although some of the exponents of the trade perhaps are not above certain "butcheries" that savages could not comprehend. Let us hope that the play on the word in this case is not deceitful.

* * *

HOW TO FALL DOWN A CHIMNEY.

A foundryman tells in the Fidelity and Casualty Co.'s *Bulletin* how to fall down a chimney without serious damage. He had directed one of his employees to inspect the inside of the chimney of a cupola furnace. The chimney was 125 feet high. It was so built that the circular aperture was less at the bottom than at the top, gradually narrowing. The employee went to the top of the chimney, and seated himself on a board, suspended by a block and tackle from a cross beam laid over the aperture. He was to be lowered in this way to the bottom of the chimney. Some part of the lashing gave way, and the man fell plumb down the chimney. With rare presence of mind he spread his elbows and knees so as to retard his fall, and finally, after dropping fifty feet, brought himself to a standstill. He was rescued with no further injuries than scraped skin, where he had pressed himself against the narrowing walls of the chimney.

* * *

An obvious error occurred in the February data sheet "Strength of 20-degree Involute Cut Teeth," contributed by Ch. J. Steen. The decimal points were omitted in the upper row of numbers for steel. Instead of reading, 0, 25, 5, 75, 10, 125, they should, of course, read 0, 2.5, 5, 7.5, 10, 12.5, etc.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

The following questions are referred to the readers:

32. F. H. M. Will you kindly inform me what effect, if deleterious, heating malleable iron to a cherry red, would have?

33. J. S. S.—How can I make an adjustable die-holder to hold any size of square pipe die, up to the limit of its capacity, for use in a screw machine? The shank of the holder must fit the holes of turret head which are 1½ inches in diameter, and the holder must be very strongly built on account of the great resistance of pipe dies cutting rough stock. A 1-inch pipe die is 3 inches square, which would be the maximum limit for capacity of holder.

Answer to No. 30.

Editor MACHINERY:

In the following I give replies to questions 2 and 3 asked by H. P. R. in No. 30 of "How and Why" in January MACHINERY. The formulas were given me by a friend, an eye specialist:

A four per cent. solution of cocaine is excellent for removing foreign matter from the eyes. An ounce of this solution will cost about 65 cents, but one must be acquainted with the druggist to get it without an order from a physician. I have used the above strength of solution for six years, with best of results. A medicine dropper should be used, and I have *never* used more than two drops at one time and seldom find more than one necessary. It causes a slight sting when dropped in the eye, and the eye should not be touched until the smarting has stopped, when the subject will not feel anything from the operation. A simple remedy for inflammation in the eye is 10 grains of boracic acid dissolved in one ounce of soft or distilled water. Put 40 grains in a four-ounce bottle, then fill bottle with water. Acid should cost 5 cents. Don't pay a druggist for putting in the water; do it yourself. Bathe inflamed eyes with this solution. ERNEST J. BUCHET.

Dubuque, Iowa.

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34. Subscriber.—I wish to repair the plunger of an ammonia pump that has been in use for 14 years. Can you tell me whether the contact with the ammonia for so long a period would affect the qualities of the iron in such a way that it would be necessary to make different allowances for a shrinkage fit, in case it should be necessary to shrink the plunger onto the rod?

A.—We referred this to the De La Vergne Machine Co., manufacturers of refrigerating and ice-making machines, who reply as follows:

In our opinion there should be no objection to this, as in our experience we have never found a case where the iron deteriorated in contact with ammonia, except where the ammonia gases were of a very high temperature, which does not occur in the practice of refrigeration.

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35. A. L. P.—What is a crown gear? I noticed an engraving in an engineers' paper some months ago of what I have always supposed to be a bevel gear, but the title or caption of the engraving calls it a crown gear.

A. The illustration to which you refer is a bevel gear; a crown gear has teeth of very narrow face, and is usually cut from sheet metal, the teeth being of the same width throughout their length, which is, as stated, very short. Hence, the resemblance to the conventional crown, and the name. Such gears run with ordinary spur gears, and are only used in light machinery, like clocks, ordinarily, although there are many instances of pin-shaped teeth, which are of this order, having been used in windmills and other old mill machinery transmitting several horse power. An instance was illustrated in MACHINERY, April, 1903, by Prof. Forrest R. Jones.

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36. C. W.—In your issue of February, 1902, you illustrated a method of power transmission with loose belts in which a keeper belt was stretched tight over the pulleys on top of the loose belt. Do you consider this arrangement preferable to the one where binder pulleys are employed?

A. In the illustration the upper view shows a loose belt drive connecting an engine band wheel with a jackshaft and the jackshaft with a dynamo. Below is the same arrangement of jackshaft, dynamo, and engine wheel connected by belts having binder pulleys. The main object of the keeper belt, as we remember it, is to keep the belt from flapping and also to keep the belt tight on its driving side when the engine is shut down, so that there will be no jumping in starting up again. The power transmitted by the keeper belt is comparatively small since it is a narrow belt. It is well known, and perhaps has been impressed upon the public largely through the advertisements of a leading maker of belt dressing, that belts properly cared for will transmit all the power they should carry when running loose. A demonstration of this is to be had in cases where binder pulleys are used. The object of the binder pulley should not be so much to keep the

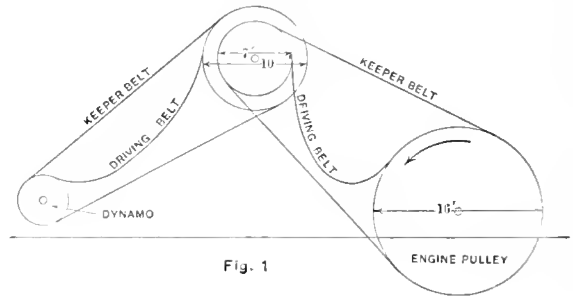


Fig. 1

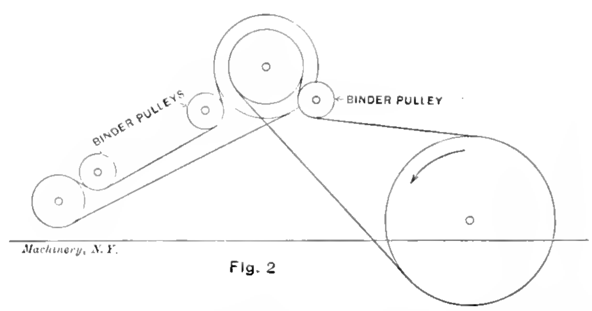


Fig. 2

belt tight as to insure its following the circumference of the pulley through as great an angle as possible. When such belts are running it is possible, if they are in good condition, to slack up on the binder pulleys for brief intervals of time and the belt will continue to follow the surface of the pulley just as it did when the binder pulley was in its original position. This would indicate that the only point of superiority through the use of binder pulleys is, or at least ought to be, that they compel the belt to follow the pulley a little further around its circumference than in the case of the drive shown in the upper part of the sketch where the keeper belt is employed. We believe the binder pulleys will give a little better result than the keeper belt, and should prefer them if it were necessary to get the utmost power possible with a given set of pulleys.

* * *

The *Times* of London has arranged to publish a weekly scientific and engineering supplement which is intended to broadly represent British engineering and science from a national point of view. In the foreword the statement is made that British engineering has not received the public and political support to which it is entitled, considering the importance of engineering to the British nation. While it is admitted that the engineering profession is very well represented by technical publications, it is thought that one of wider scope and greater variety of readers is now needed to give engineering dignity and general standing, hence this unique departure in newspaper publications. The standing of the *Times* and its generally accurate and authoritative statement of affairs is a substantial guarantee of what the character of the new publication will be, and we look for the first issue with much interest.

* * *

The annual general meeting of the Iron and Steel Institute of Great Britain will be held at the Institution of Civil Engineers, May 11 and 12, 1905. The autumn meeting will be held in Sheffield September 25 to 29, 1905.

SHOP RECEIPTS AND FORMULAS.

Practical Tried Receipts—those known to be Good—are Solicited.

TO HEAT THE TIPS OF SMALL TOOLS.

Sometimes it is necessary to heat, for the purpose of hardening or annealing, the tips of small tools, such as counter sinks, etc. To do this without heating other portions of the tool is at times difficult to accomplish. If the tool is inserted into a raw potato, exposing only the part to be heated, the operation is easily performed.

South Portland, Me. J. V. N. CHENEY.

FORMULA FOR CASEHARDENING PREPARATION.

Yellow prussiate of potash, by weight, 7 parts; bichromate of potash, 1 part; common salt, 8 parts; pulverize the crystals and mix thoroughly. Heat the piece to be hardened to a dark red and dip into the preparation or sprinkle it on the piece. Return to the fire and let it soak, then repeat several times according to the depth of hardened surface wanted. Finally plunge into water or oil. This may be used on tool steel, soft steel or iron. JAMES P. HAYES.

Meriden, Conn.

COLORING STEEL.

Having occasion to darken polished spots on casehardened parts in order to make the entire pieces appear uniform, I immersed them for about 20 seconds in a solution made as follows: Eight cubic centimeters of nitric acid and 40 cubic centimeters of water, same being measured by a druggist. The pieces I refer to were casehardened in the usual manner (packed in bone dust). After immersing as above stated, rinse off in clear running water and you will not be able to distinguish the difference between the part which was formerly bright and the dark portion.

Chicago, Ill. HARRY ASH.

TO RECUT OLD FILES.

Dissolve four ounces of saleratus in one quart of water and boil the files in it for half an hour, wash and dry them. Have ready in a glass or stoneware vessel 1 quart of rain water to which 4 ounces of best sulphuric acid have been slowly added, keeping these proportions for any amount used. Immerse the files in this preparation, then wash them clean, dry quickly and cover with a little sweet oil. Coarse files should remain in the diluted sulphuric acid for about 12 hours, though from six to eight hours are enough for fine ones. Files may be recut three times by this process, and the liquors may be used at different times if desired. R. B. CASEY.

Schenectady, N. Y.

SILVER PASTE FOR BRASS.

This paste is used for silvering the scales on thermometers and the dials for clocks, aneroid barometers, steam gages, etc.

Put in an ordinary tea cup or other suitable vessel, 1 ounce of silver—coin silver will do, but pure silver is better and cheaper. Fill the cup half full of nitric acid, and place it in a vessel containing water, which must be heated. As the acid heats, it throws off fumes in shape of a brown smoke, very poisonous. When the smoke ceases to appear, add a teaspoonful of common table salt, and when the fumes caused by this cease, take the cup from the heat immediately and fill slowly to the top with cold water. Allow the white powder that will now be found in the cup to settle to the bottom and then slowly decant the liquid. When almost empty, fill again with cold water, and decant again, repeating this process at least half a dozen times. Mix the powder (commercial chloride of silver will do instead) with 10 pounds table salt, and ½ pound cream of tartar. Mix thoroughly dry, then add enough cold water to make a paste. Add the water slowly so as not to get in too much. Keep in a covered vessel and from the light.

The graduation marks, figures, and letters, stamped or cut into the work may be filled with ordinary roofing tar, which is applied by heating the work enough to melt the tar. Most of the surplus tar may be scraped off with the edge of a card or any cardboard handy. This filling stands better than sealing wax, and will not dissolve and blur when lacquered if the lacquer is put on properly. Another filling is japan which is applied with a brush cold, and cleaned with a card as before. It is then baked, and when the work is finished the filling will be found to be glossy and permanent and will not be dissolved by any lacquer or heat.

The piece to be silvered should be thoroughly cleaned with emery cloth or paper just before applying the paste, which is to be put on by hand and rubbed well in the surface of the work. After this is done, the work should have a dirty, silvery yellow tinge, which will be brightened by rubbing with a dry mixture of ½ pound cream of tartar and 10 pounds salt well mixed. The work should be thoroughly washed to clear it of the surplus salt and then dried in sawdust and lacquered. I have used this method for silvering over 30,000 steam gage and clock dials, and many other dials and scales, hence I know it is all right. J. S. GORDON.

Brooklyn, N. Y.

GRANT'S RECEIPT FOR WHITEWASH.

W E G

No doubt some time or other one of the many readers of MACHINERY has had occasion to whitewash the ceiling or wall of his factory, barn, or other buildings, and wondered what was the best whitewash and how to make it. Possibly he recollects an instance a month, or it may be a year or more, ago, when he whitewashed his shed or fence and used a common whitewash mixture that a neighbor gave him, and after he had put it on and allowed it to become thoroughly dry, doughnuts to dollars it cracked or peeled off. This is particularly the case with common whitewash when applied to the interior of factories or buildings where there is more or less vibration. Noting the condition of his shed, and remembering the time and money he had spent fruitlessly, he resolved to never use whitewash again, paint being good enough for him. Had this whitewash remained where he had placed it and retained its clear snowy whiteness, this same man would have looked on the brighter side of life and been a staunch advocate for whitewash. Nothing looks more cleanly on the interior or exterior of a building, especially an old one, than a nice snowy coat of white paint or whitewash; and whitewash, if of the right kind, is the cheaper and preferable where a large surface has to be covered. A receipt for a good whitewash is generally in demand, and the one that I am about to give you was sent by Gen. U. S. Grant, then President of the United States, to his old friend, Gen. I. Bulson, who was stationed at San Francisco.

Gen. I. Bulson, wishing to whitewash some of the buildings around the barracks and hearing that Gen. Grant had a receipt for a very good whitewash, wrote to him requesting a copy of the same. The following is an exact copy of the letter received a few weeks later:

Brilliant Whitewash.

Washington, Dec. 1, 1871

Half a bushel unslacked lime; slack with warm water, cover it during the process to keep the steam; strain the liquid through a fine sieve or strainer; add a peck of salt, the same to be previously well dissolved in warm water; add three pounds of ground rice boiled to a thin paste and stir in boiling hot; add one-half pound of glue which has been previously dissolved over a slow fire and add five gallons of hot water to the mixture; stir well and let it stand for a few days covering up to keep out dirt. It should be put on hot. One [illegible] of the mixture, properly applied, will cover a square yard. Small brushes are best. There is nothing can compare with it for outside or inside work and it retains its brilliancy for many years. Coloring matter may be put in and made of any shade—Spanish brown, yellow ochre or common clay, etc.,

Yours truly,

U. S. GRANT

To my dear friend, I. Bulson,

San Francisco

P. S.: I whitewashed the White House all over with it.

U. S. G.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

LUNDELL UNIVERSAL MOTOR.

A short time ago an arrangement was made between the National Electric Co., Milwaukee, Wis., successors to the Christensen Engineering Co., and Mr. Robert Lundell, for the National Electric Co. to manufacture and market Mr. Lundell's new line of universal motors. These motors are remarkable for their overload capacity, and in many respects their construction is quite a radical change from the usual practice. Some of the latest patents of Mr. Lundell are for a new type of motor and dynamo frame construction, and a new method of

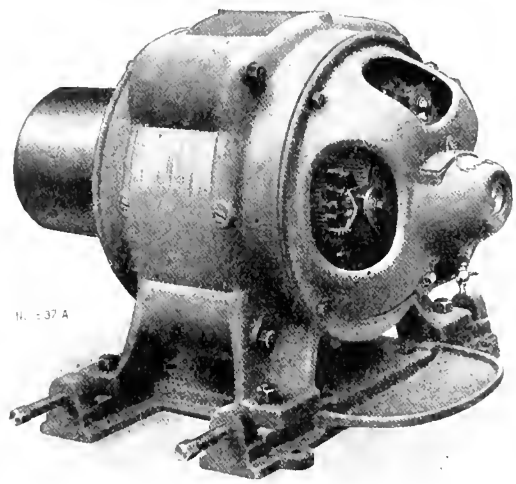


Fig. 1. Lundell Universal Motor.

commutation by which there is a material gain in space occupied, increased efficiency, and considerable flexibility of regulation and speed control.

The general appearance of the new motor is indicated by Fig. 1. The cast-iron frames or housings, which contain the laminated yoke rings, consist of a rigid open casing made in two parts, front and rear, as shown in Fig. 2. The rear part has four hollow extension arms, accurately bored to engage

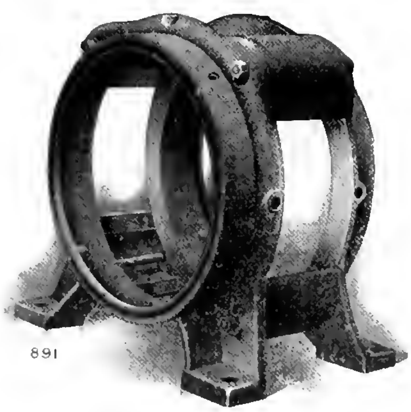


Fig. 2. Frame of Motor.

Fig. 3. The Laminated Yoke.

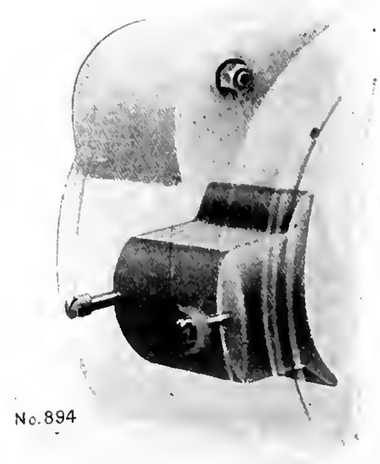


Fig. 4. Pole Piece in Place.

and support the laminations assembled therein. The front and back frames are secured together by bolts passing through these arms. The frames so connected make a very stiff construction, which is in no way dependent for its stability and the alignment of the machine upon the yoke laminations being in place.

The construction of the laminated yoke is shown by Fig 3. The entire magnetic circuit is made up of laminated mild steel in the yoke, pole pieces, and armature body. These yoke rings are secured and accurately centered in the frame just described. The pole pieces are separately punched from the same material as the yoke rings. They are provided with end plates constructed so as to furnish ventilating ducts to carry off the heat generated in the field coils. Retaining bolts pass through these end plates and the frames, accurately setting the pole pieces, and causing them to make good contact with the inner diameter of the yoke rings as shown in Fig. 4.

It has not been found necessary to introduce ventilation into the center of the armature in machines up to 60 H. P., since the losses have been found to be very low. The armature coils are all form-wound and are separately insulated. The commutator shells are ventilated through their centers. The bars are made of hard-drawn copper insulated by mica. One of the interesting features of the motor is the arrangement of the brushes, which are not, as is customary, placed

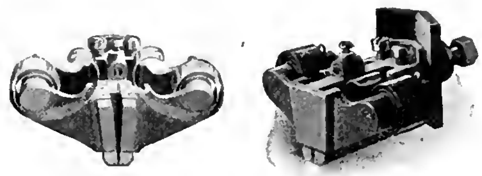


Fig. 5. Brush Holders.

side by side on a stud in a line parallel to the commutator bars, but are placed one directly in front of the other in tandem. The total brush surface is the same as that occupied by the side-by-side brushes, but the advantage is gained that any possible irregularity of the commutator surface strikes only one brush of a stud at a time, so that while one brush may jump, its mate is making contact, and the circuit thus remains closed for that stud, each brush having its independent tension spring. It is stated that this arrangement of the brushes greatly reduces the temperature of the commutator, and greatly aids in obtaining broad ranges of variable speed. Where conditions of service call for special commutating conditions, the brush at the leaving edge is made of high-resistance carbon to take care of the sparking conditions, and the other of high conductivity to carry the current. The brush holders are shown in Fig. 5.

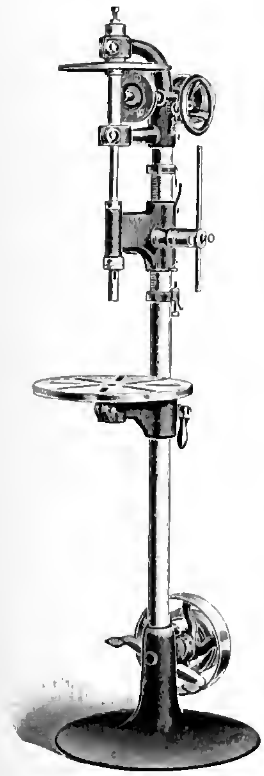
It is stated that the construction of the Lundell motor is particularly advantageous in variable speed motors for direct connection to machinery, and is equally valuable for series parallel control, etc.

A NEW FRICTION BALL BEARING DRILL.

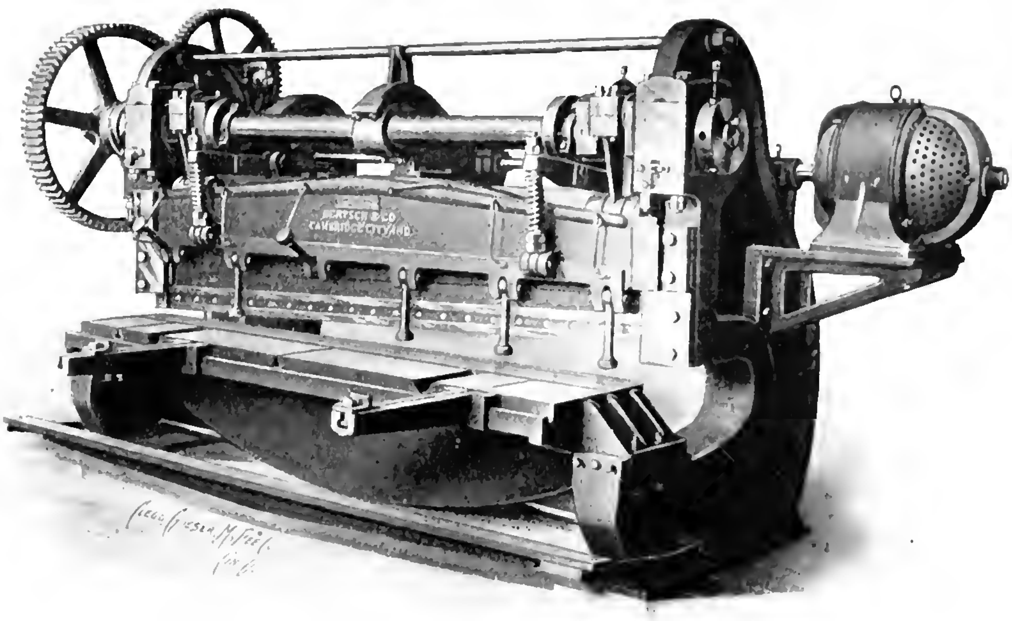
A new sensitive drill just placed on the market by the Francis Reed Co., 43 Hammond Street, Worcester, Mass., (shown on next page) has a number of noteworthy points of construction. It is designed to meet the demand for a light sensitive drill that will handle the new high-speed steels. With this point in view the head is made to slide on the standard by means of the manipulation of the lever, thus giving a special rigidity to the spindle. The spindle has a ball-bearing thrust collar and is provided with a Morse No. 1

taper. Its travel is 10 inches. Stop collars are provided to limit the travel of the head, the lower one having an adjustable screw for more accurately gaging the depth of hole drilled. The head is counterbalanced by an adjustable spring.

The rotation of the spindle is through friction plates, the driven plate being placed above the friction driver, so that the working surfaces are protected from dirt; and, the weight of the friction plate and its shaft being always on the driver, a forced contact by means of a screw is largely unnecessary.



Reed Friction Drill.



Motor-driven Shear.

For whatever adjustment is thought desirable, however, such a screw is furnished on top of the friction plate shaft. This screw is intended for hand manipulation only, and a wrench should not be used.

The screw presses on a ball-bearing plate with a spring to give a flexible pressure on the friction-plate shaft, which also runs on ball bearings. A speed variation of from 1 to 3 can be obtained by turning a handwheel on the right-hand side of the machine, and thereby altering the working diameter of the friction-plate.

A serviceable feature of the drill is the friction clutch shown at the base. The operator starts the machine by pressing down the lever on the right, while by pressing down the lever on the left side he stops the machine.

The machine occupies little floor space and belts direct to the line shaft, requiring no countershaft. The base of the machine is 20 inches in diameter, the table is 15 inches in diameter and can be adjusted vertically through 27 inches. The greatest distance from the spindle to the table is 32 inches. The steel supporting column is 2 inches in diameter and is solid. The friction plate and friction driver are 10½ and 5 inches in diameter, respectively. The total height of the drill is 72 inches. Its weight is 210 pounds. At a test made with these drills a 9-16-inch drill bored 4 inches through solid cast-iron in 1½ minutes.

MOTOR-DRIVEN SHEAR.

The accompanying half-tone engraving presents a new shear recently designed by Bertsch & Co., Cambridge City, Ind.

This shear has been designed especially to meet the requirements of rolling mills, where the service is particularly heavy. Such a shear is also necessarily suitable for general shearing in sheet iron shops.

The cut shows the shear built with the makers' patented hold-down device which is actuated by cams on the main driving shaft, and so designed that it is self-adjusting for all thicknesses of metal. In this the pressure legs or gags and not the solid portion of the hold-down, clamp the sheet; consequently the shearing line can be seen at all times, and further, narrow strips can be sheared conveniently without danger to the operator. These legs or gags can be turned up and locked easily, thus converting the machine into a plain shear without a hold-down, which permits of the top blade being removed and replaced without taking off the hold-down casting.

The shear is also provided with a patented center bearing, which consists in an adjustable wedge fitted between a bearing on the rear of the crosshead and another bearing on the heavy cross-tie casting bolted to the two housings. This is intended to make it impossible to spring the main crosshead

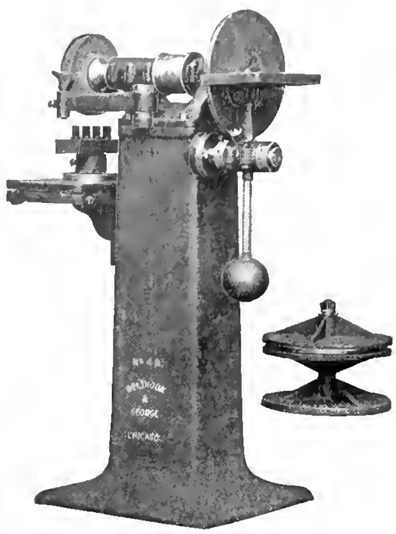
This shear is triple geared, with the gears rigidly supported and self-contained. It has a four-jaw clutch with steel faced jaws, and a cast steel switch ring acting against a steel plunger with a hardened steel roller that is positively controlled.

The crosshead bearings are provided with brass gibs for taking up wear. The crankshaft bearings are made of bronze set in split boxes that are easily adjustable or removable. The crankshaft and main crosshead are easily removable. The shear is furnished with motor, engine or belt drive.

COMBINATION DISK AND DIE GRINDER.

The disk and die grinder shown on next page is a new model recently brought out by Delivouk & George, 122 South Clinton Street, Chicago. The disk seen to the right in the illustration is covered with emery paper or cloth, which may be secured to both sides of the wheel by a quick-drying cement. For this operation the wheel is clamped in a press furnished for this purpose, shown back of the machine. These disks covered with emery paper are very rapid cutting devices. The table shown to the right has a rocking motion which distributes the motion to the full surface of the disk; it can, however, be clamped rigidly in position or set at any angle from 45 to 90 degrees, which is a valuable feature in some work. This disk is adapted to grinding off rough surfaces on drop forgings, castings, etc., and also to finishing work.

The emery wheel at the left of the machine is useful for ordinary grinding, or for rough grinding before applying the work on the disk. This table is hinged to a bracket on one end, with a screw under the opposite end by which a fine adjustment of feed can be attained. This bracket has a vertical adjustment of 14 inches, is counterbalanced by a weight inside the pedestal, and can be securely fastened to the column by the movement of a cam lever. For the grinding of punches a holder is furnished to receive the shank, as shown in the cut. By its use punches can be easily ground to the same height or sharpened. In place of the emery wheel, a cup wheel or

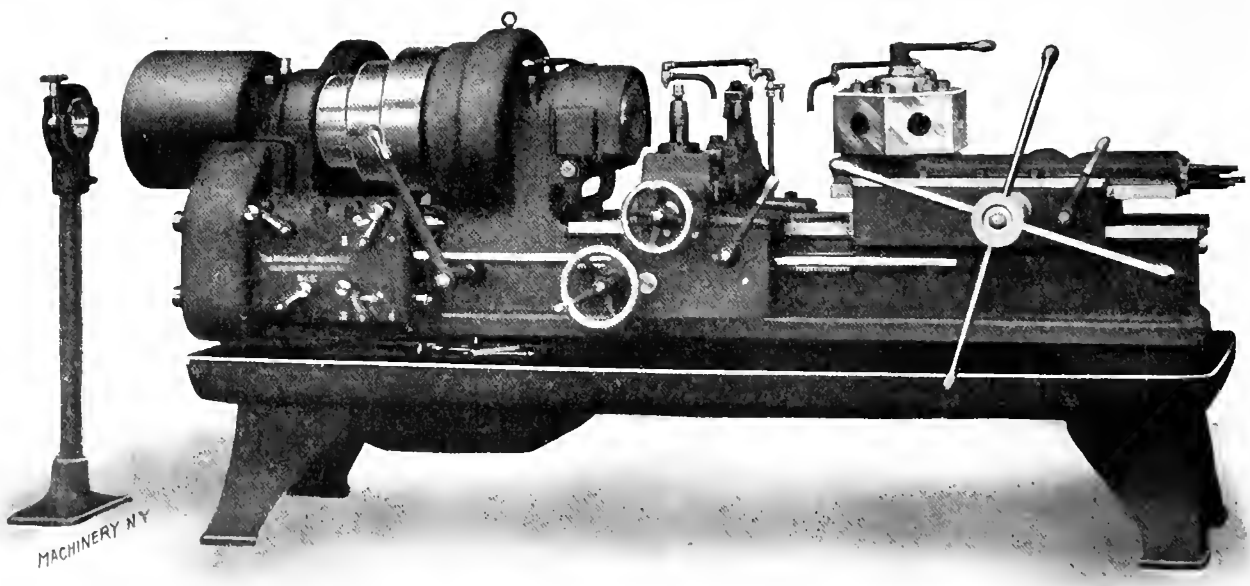


Combination Grinder.

disk can be used if desired. The bearings of the machine are dust proof, and all wearing surfaces are provided with adjustments. Hardened rings are provided for end thrust.

A NEW TURRET SCREW MACHINE.

A turret screw machine of new design which is being brought out by the Warner & Swasey Co., Cleveland, O., is shown in the accompanying cut. This machine has a swing over bed of 20 inches, and takes bar stock up to 3⅝ inches in diameter; the turret slide travels 14 inches. The head and bed are cast in one piece, thus insuring rigidity. The cone has three steps for a 4-inch belt, and is geared 1.85 to 1, and back geared 7.44 to 1, the back gears being engaged and disengaged by friction clutches. Twelve spindle speeds give a range of from 15 to 156 revolutions per minute.



Turret Screw Machine.

Features of the machine are an automatic chuck and the power roller feed. The chuck is operated by the long lever in front of the head, which works through a system of compound levers. The same lever also engages and disengages the roller feed. The chuck jaws are adjustable for variations from actual size to 1-16 smaller.

The turret saddle is provided with a supplementary taper base, by means of which the center of the tool holes of the turret can be adjusted to the exact height of the center of the spindle. Taper gibs extending the whole length of the saddle on each side provide means for adjusting the slide sideways. The turret slide is equipped with geared automatic feed which gives four changes in either direction, from 20 revolutions of spindle to 1 inch feed, to 102 revolutions. The turret is hexagonal and has tool holes 2½ inches in diameter, and also bolt holes for attaching tools to the faces. Stock of any diameter smaller than the tool holes can pass entirely through. The index is nearly the full diameter of the turret, and a lock bolt is placed directly under the working tool. Independent adjustable stops are provided for each face.

The carriage has a geared automatic cross feed with four changes in either direction, from 61 revolutions of the spindle to feed 1 inch, to 306 revolutions, and a hand longitudinal feed. A toolpost for holding forming and turning tools, aud a cutting-off tool holder, are provided. Any of the changes of feed is available by shifting a lever in front of the gear box. The turret and carriage feeds are independent of each other, and both are provided with adjustable automatic trips.

A geared pump delivers oil to the cutting tools of both the turret and carriage through two systems of piping, and operates when running in either direction. A double friction countershaft accompanies the machine, arranged for belt drive, but a motor drive can readily be applied.

FORTY-TWO INCH BORING AND TURNING MILL.

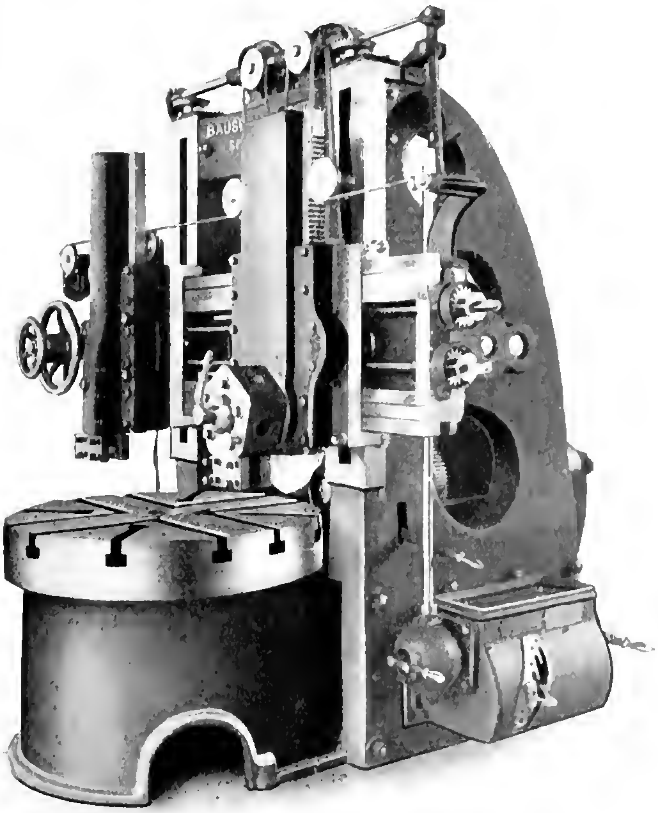
The Baush Machine Tool Co., Springfield, Mass., have designed and put on the market the boring and turning mill accompanying this description As regularly made this mill has one turret head and one swivel head. Its capacity is work 44 inches in diameter, 37 inches in height under the cross rail, or 31 inches under the tool holder. The table is 42 inches in diameter, is powerfully geared, and has ten changes of speed, five with back gears and five without. This gives a range of table speeds of from 20 revolutions per minute maximum to a minimum speed of 6 revolutions.

The teeth of both the table and pinion are of steel. The table spindle is 10 inches in diameter and 22½ inches in length. It has a straight bearing which acts in conjunction with an angular bearing to receive the side strains. There is also a thrust ball bearing on the lower step of the spindle, which acts as a preventative against any lifting tendency, and relieves the frictiou of the table when a heavy cut is being taken. On the under side of the table there is an outer bearing nearly equal to the diameter of the base.

The turret slide shown on the right hand in the figure can be set to bore, turn and cut 8 and 11½ threads per inch, and has a vertical movement of 24 inches. The turret has five sides 10 inches across the flats, and has five 2 5-16 inch holes. The heads are entirely independent in their movement, both as to direction and amount of feed. The swivel head on the left can be brought to the center for boring. It as well as the turret head has a vertical movement of 24 inches. The heads are attached to steel feed-screws by split nuts which can be opened and a rapid movement obtained by ratchet and

pinion engaging a steel rack on the cross rail. The feeds are positive and have fifteen changes, ranging from 1-64 inch to 61-64 inch horizontally, and from 1-64 inch to 9-16 inch in angular and vertical directions.

The cross rail can be raised and lowered by power without revolving the table. The back gears can be changed by means of a lever without the use of a lock nut. The countershaft has tight and loose pulleys, the driving pulley being 20 inches in



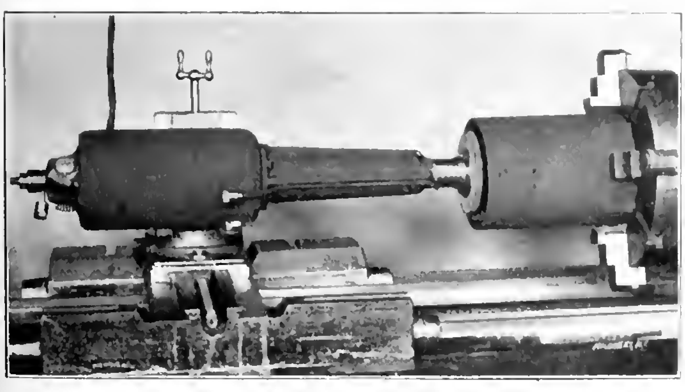
Baush 42-inch Vertical Mill.

diameter for a 4½ inch belt; it should run at 300 revolutions per minute. A band brake operates on the main driving cone by hand. As this machine is self-contained it should not require an elaborate foundation.

NEW MOTOR-DRIVEN INTERNAL GRINDER.

Herewith is illustrated a portable electrical internal grinder. This tool is especially designed for grinding and finishing up gas, steam and air cylinders, grinding out dies, truing up bearings, and for cylindrical grinding of any kind.

The grinder weighs 76 pounds, and the motor will develop about 1 H. P. The minimum size of hole in which this machine



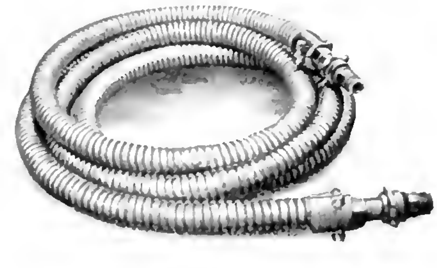
Internal Grinder with Motor Drive.

will grind is 3½ inches. The dimensions of the motor are 6 x 12 inches, and the spindle extends 12 inches.

This grinder is bolted to the toolpost rest of the lathe by means of an angle plate, and has a vertical adjustment to bring it in line with the centers. The driving power is obtained from an ordinary incandescent lamp socket, direct current. This machine is being put on the market by the Hisey-Wolf Machine Co., Cincinnati, O.

FLEXIBLE STEEL-ARMORED HOSE.

The demand for a steam or air hose which could be absolutely relied upon has led the Sprague Electric Company to enter the field with a new product which is felt to meet the requirements, so that the trainmaster, the mechanic or the

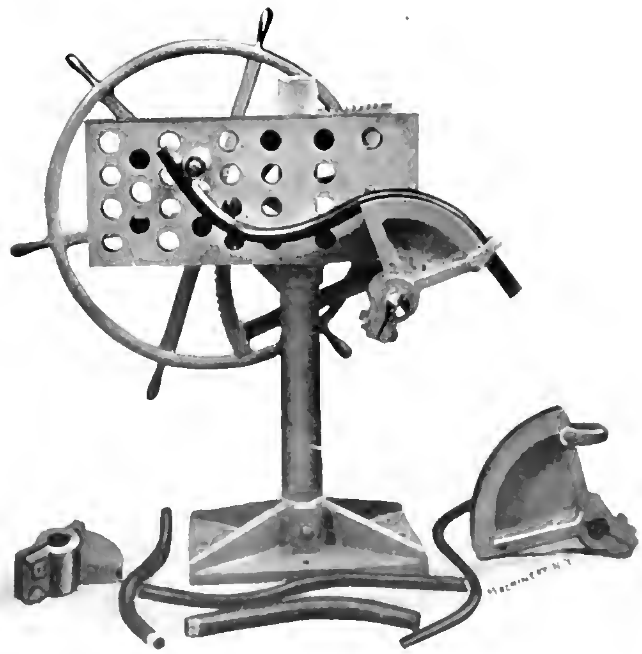


Flexible Steel-armored Hose

quarryman can feel assured that he is safe from serious accident due to defective hose. The new product is known as "flexible steel-armored hose" and consists of a suitable rubber hose encased in a steel armor which prevents expansion and thus greatly increases its life. The armor also protects the hose from mechanical injury and insures flexibility by making it impossible to flatten or kink when handling. In ordinary rubber hose, when over-vulcanization occurs, it bursts and is immediately useless, whereas if a crack should occur through over-vulcanization in the flexible steel-armored hose, the steel armor binds the rupture so tight that very little pressure is lost and the work in progress does not stop. This permits the hose to be used until a new piece can be obtained, and not only saves time, but, in many cases, human lives. In any case it is a money-saver. The accompanying illustration shows the general appearance of the hose. The manufacturers have issued Bulletin No. 50518, describing it, which will be sent upon request by addressing the Sprague Electric Company, 527 West 34th Street, New York City.

PIPE BENDING MACHINE.

Pedrick & Smith, 222 Girard Avenue, Philadelphia, Pa., have just brought out a machine for cold-bending pipe to any desired curvature. The machine is operated by a handwheel which carries a pinion. The latter engaging a quadrant gear operates the bending quadrant. One end of the pipe is held in



Machine for Cold Pipe Bending

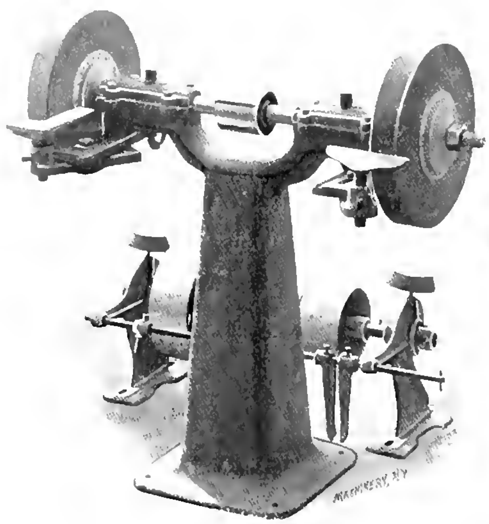
position by a U-shaped clip, while a pin or roller in the platen engages the pipe toward the other end. The placing of the pin or roller in the different holes governs the curvature obtained.

The Pedrick & Smith pipe-bending machine is light in weight, and can be readily carried to the work from the shop, and can be either secured to any available support or mounted on its own stand, as shown in the illustration. It is stated that piping of steel, iron, brass, copper, or other material, can

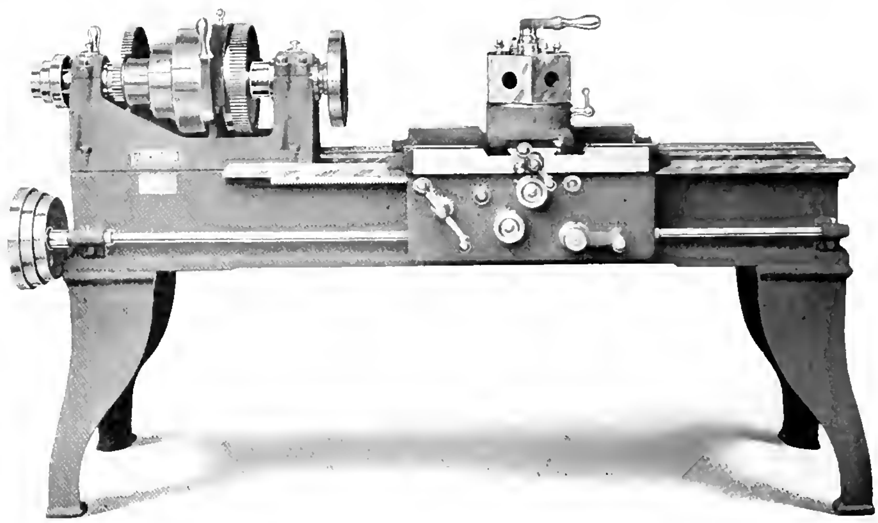
be bent cold up to 2 inches diameter with the services of but one man. It is also said that where pipes are coated by the Sabin process, or galvanized or tinned, this machine will perform any desired bending operation without breaking the coating in any way.

STERLING GRINDING AND POLISHING MACHINE.

The photograph below is of a new grinding and polishing machine manufactured by the Sterling Emery Wheel Manufacturing Co., Tiffin, O. It is intended for the general servcie to which emery wheels and polishing wheels are put in the foundry and machine shop. It has a spindle 48 inches long, and is 35 inches high. The bearings are 10 inches long, and 1⅝ inches in diameter; the distance between the flanges is 34 inches. The boxes are self-oiling. Tight and loose pulleys can be placed on the arbor, or a countershaft can be supplied where necessary. The weight of the grinder is 435 pounds.



Grinding and Polishing Machine



American Manufacturing Turret Lathe.

AMERICAN MANUFACTURING TURRET LATHE.

The American Tool Works Co., Cincinnati, O., have just brought out a new turret lathe which has been designed and built specially for the use of automobile builders, gas engine manufacturers, and others having similar lines of work which require a powerful, rigidly built tool to stand up under the usage of high-speed tool steel. The lathe illustrated herewith has a bed of patent drop V pattern, which gives 2 inches additional swing. The spindle is of high carbon special steel, with a hole of large diameter throughout. The bearings are of phosphor bronze, with means for any necessary adjustment.

The carriage is heavy, especially in the bridge, and has continuous bearings on the ways; it is gibbed to the bed for its entire length. The turret slide has full bearing across the carriage in a wide dovetail; a very long gib is used on this slide. The turret, which is made heavy, is hexagonal, and has no overhang. It is provided with a substantial locking device of tool steel.

There are three feeds, both cross and longitudinal, obtained through a belt-driven feed rod. Friction locking devices are used in the apron. A stop is furnished for properly locating the turret centrally for boring.

This lathe is made in various sizes with either plain back-geared or friction-geared head, belt or geared feed, and with or without a screw cutting feature and other usual engine lathe attachments.

COAL OIL SHOP FORGE.

The Burke Machinery Co., Cleveland, O., have just introduced a coal oil forge for machine shop use in hardening and tempering dies, forging and dressing shop tools, and similar work which is not too large to get into the dome of the forge. The forge, illustrated herewith, consists of a main stand or tank casting, which is built to withstand a test pressure of 100 pounds to the square inch, and which will hold enough coal oil to run the forge for several days. Oil is forced by air pressure on top of the oil through pipes which extend from the bottom of the oil tank to the burners. The burner is a standard hydrocarbon coil burner, equipped with one needle valve and one regulating valve. It is inclosed in a cast-iron case which retains the heat and prevents ill effects from unnecessary draft should the forge be used out of doors. On top of the tank casting is a fire brick dome consisting of five pieces—the dome proper, a plug for filling the hole in the top, a piece to set in the back closing the rear of the forge, an angle plate to set against the front to close the latter after the work has been placed inside, and a small fire brick table to be placed inside the forge when delicate work is to be hardened. When the brick in the top of the dome is removed, a small melting pot can be placed in the top of the forge and used for melting babbitt, lead hardening, etc.

Coal Oil Forge.

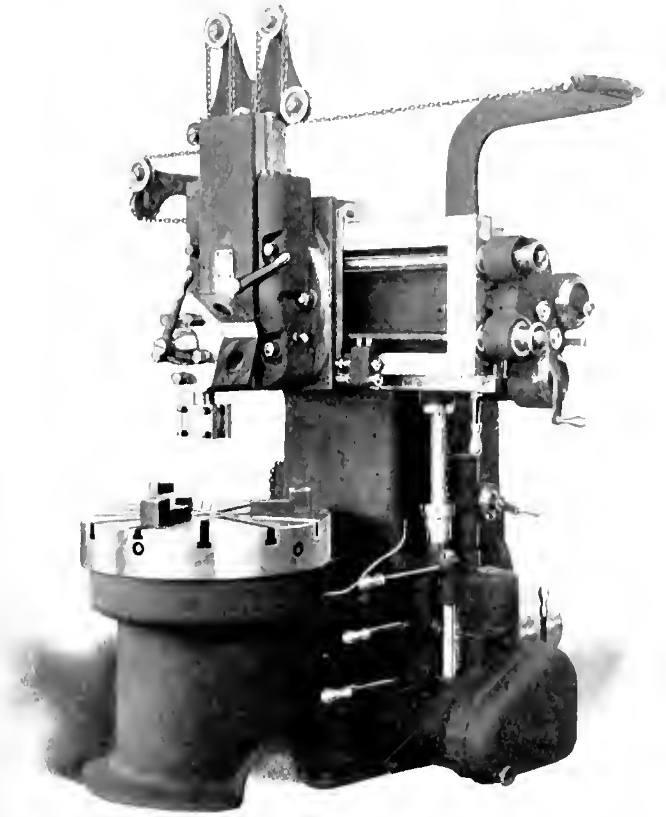
The forge is self-contained and therefore portable. The opening in the dome is 5 inches wide, 4½ inches high, and 8 inches deep. The oil passing through the coil burner is turned to gas which, when blown from the regulating valve, makes

its own mixture with the surrounding air, no blast of air being considered necessary. A cloth filter is placed in the pipe between the burner and the tank to prevent the clogging of the burner by coal oil sediment.

When once pumped up the compressed air upon the oil in the tank casting operates the forge for half a day or more, depending entirely upon the heat required. For ordinary shop work a pressure of from 25 to 30 pounds gives sufficient heat. For melting tool steel 75 pounds pressure is required. For ordinary pressure about 1½ gallons of coal oil for a working day of ten hours are consumed. It is stated that a heat of from 2,200 to 2,500 degrees F., which is requisite for hardening and tempering high-speed tool steels, can easily be obtained with this forge.

GISHOLT VERTICAL MILL.

We show in the accompanying illustration a 34 inch vertical mill which has just been brought out by the Gisholt Machine Co., Madison, Wis. This machine differs from the former vertical mills of this company chiefly in the headstock; in all machines except this the friction back gear headstock has been used, but on the 34-inch there is a four-step cone pulley drive, and back gears are thrown in and out by means of a positive



Gisholt 34-inch Vertical Boring Mill

clutch operated by a lever. The machine is fitted with feed tripping devices similar to those used on the larger sizes, by means of which any feed may be automatically stopped at any point. The feed screws are all fitted with micrometer index dials, reading to .001 of an inch. The two-speed countershaft provides sixteen table speeds. Eight changes of feed are provided, all of which are operated either by power or by hand. The spindle drive is of the spur pinion variety. As illustrated, the machine has a swivel turret head with a screw cutting attachment, but it may be made with a plain head, and without the attachment.

ANDREW MULTIPLE IRON DRILLING MACHINE.

A new design of multiple iron drill put out by M. L. Andrew & Co., Cincinnati, O., is herewith illustrated as Fig. 1. These machines are built in different sizes, having capacities up to the drilling of fifty holes in steel at one time. The largest machine of this type built by the firm weighs 28,000 pounds and can drill twenty-four 1¼-inch holes in steel at one operation.

Holes of different sizes can be drilled either on a straight line or staggered. Fig. 2 shows the arrangement of the spindles, the cut to the left for straight line work, and that to the right for staggered drilling. The spindles are fitted with long taper and thrust ball bearings; they are bored to suit either straight or Morse taper shank drills. Each spindle is adjustable, and driven by carbonized phosphor-bronze bevel gears.

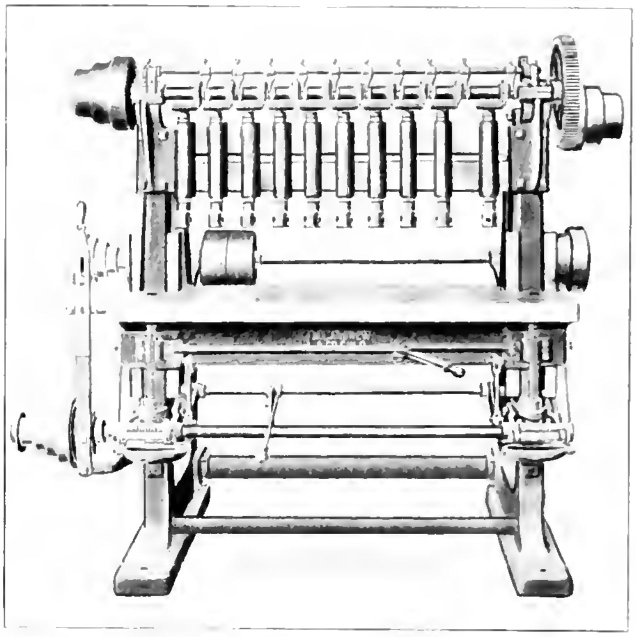


Fig. 1. Andrew Multiple Drill

The table is counterbalanced and fitted with both hand lever and automatic screw feed. There are provided automatic stops to gage any required depth of holes to be drilled. There are four changes of table feed and a quick return stroke. The main driving shaft is driven from both ends, one end being fitted with a 3-step cone pulley and compound gear for heavy work, while the other end may be driven from a 3-step cone direct, for rapid light work. Each table is provided with rotary pump and tanks for oil or other lubricant.

HANDY COMBINATION MICROMETER.

The micrometer measuring device shown in the cut is an instrument designed and made by Mr. E. G. Smith, Columbia, Pa., principally for use in colleges and engineering schools, for laboratory measurements, but owing to its general adaptability it has been found to have many uses in machine shop and other manufacturing plants. It can be made with a screw

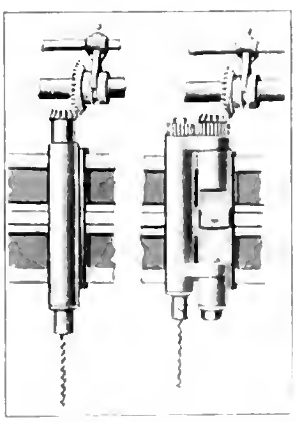
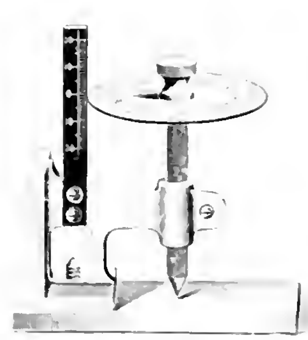


Fig. 2. Arrangement of Spindles. Andrew Drill



Smith Combination Micrometer

cut with a thread of 1 millimeter lead, in which case using a disk divided into 100 parts gives readings of 1/100 millimeter or if the screw is cut 20 threads per inch and a disk with 50 divisions is used, the readings are in 1/1000 inch. It is pointed out by the maker that two of these instruments on a long true surface plate, with the two measuring screws facing each other, make a simple and accurate measuring instrument of

a length limited only by the length of the surface plate, and one that can be constructed at small cost. Such use, of course, would require a set of standard test or measuring bars for setting the heads. It does not appear to us, however, that more than one such head is really essential, since any means for holding a pointed center or other abutment at the required height would serve equally well at one end. This device can also be used for a depth or height gage.

BORING TOOL HOLDER.

The boring tool holder shown in two views, Figs. 1 and 2, is a device recently patented and placed on the market by Carr Bros., Syracuse, N. Y. It consists of a shank and clamp, and

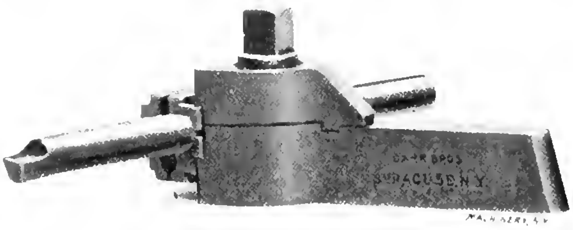


Fig. 1. Boring Tool Holder.

a steel block perforated longitudinally with four holes of varying sizes for the four sizes of round tool steel, 1/4, 5-16, 3/8, and 1/2 inch diameter. The block is dovetailed on four sides to fit the clamp, and is slotted through to each hole so that the clamp can pinch the sides of the block firmly upon the tool.

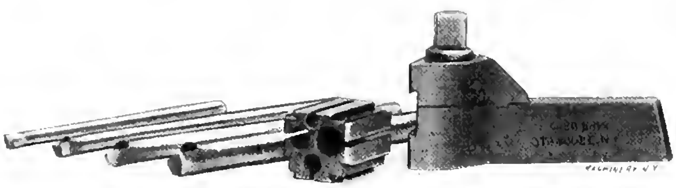


Fig. 2. Parts of Boring Tool Holder.

While the tool is designed for general use, it is particularly adapted to the wants of toolmakers and other workmen who require a large variety of boring tools, which, when forged, are the most expensive lathe tools to make.

EMMERT QUICK-ACTING MACHINISTS' VISE.

The "Presto" quick-acting vise brought out by the Emmert Mfg. Co., Waynesboro, Pa., is shown in the accompanying half-tone, Fig. 1, and in section in Fig. 2. The vise is made

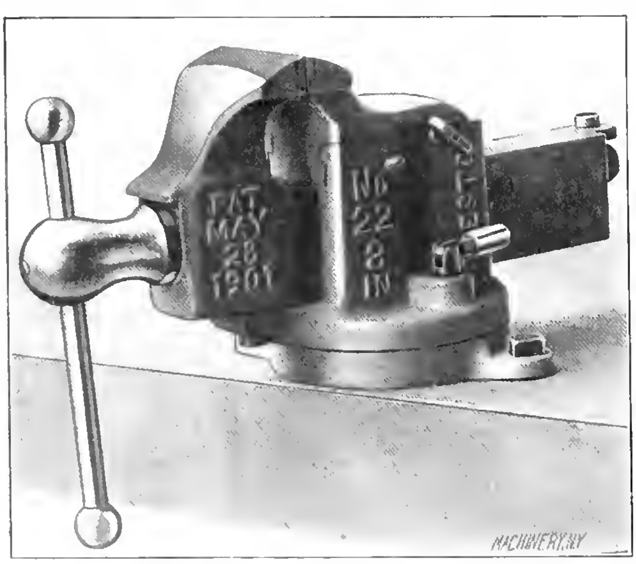


Fig. 1. Emmert Quick-acting Vise.

in all sizes and styles, ranging from 3-inch to 6½-inch jaws. The quick-acting feature may be understood by reference to the sectional view, Fig. 2. The toothed pawl which engages the toothed base rack, both being of steel, is seated in the solid nut block, and is forced into or out of engagement with the rack by the stationary pin, and held in either position without the aid of springs. The quick-acting feature is put into operation by a quarter turn of the handle to the left, when the pin raises the pawl out of engagement, and the workman can immediately set the jaws of the vise to the proper size of

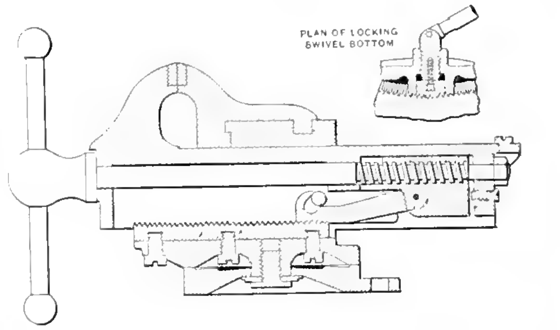


Fig. 2. Sectional View of Vise, showing Quick-acting Movement.

the work. A quarter turn of the handle to the right will then securely hold the work, the first movement of the handle releasing the pawl from the pin, allowing it to drop into engagement with the rack.

* * *

Diesel engines burning crude oil have been running electric generators which operate street cars and electric lights for the Key West Electric Co. for over a year. The internal combustion engine seems to be very applicable in this district on account of the high cost of coal and the comparative cheapness of oil. The fuel costs of the Key West Electric Co. are said to have been reduced from $24,000, when using the steam engines, to less than $6,000 with the oil engines. The old steam plant used 5 pounds of coal per K. W. hour on the average, which cost $5 per ton, whereas the oil engines only use about 7-10 pound of oil per K. W. hour at 3 cents per gallon. The whole plant of this company will shortly be operated by oil engines, and all of the steam engines shut down.

* * *

FRESH FROM THE PRESS.

ELEMENTARY COURSE IN MECHANICAL DRAWING, PART 1. By Arthur W. Chase. 189 pages, 7 x 9, oblong. Illustrated by 95 figures. Published by Howland Speakman, Chicago, Ill. Price $1.50.

In this work Mr. Chase, who is instructor of machine drawing and design in the R. T. Crane Manual Training High School, Chicago, Ill., has outlined the result of several years' experience in placing the subject before manual high school pupils. The object of the work has been to stimulate the thinking qualities of the pupils and to prevent mere copying. All plates required in the course are omitted, as are also time-consuming exercises designed to give skill in the use of instruments only. The student is given a problem from which he must construct the drawing without following any other guide save the printed instructions. A large number of geometrical problems are given as an introduction to the course. In defending this practice the author says that plane geometrical drawing is the foundation of all drawing either for industrial or artistic purposes. It involves the construction and representation of only two dimensions, and therefore is more easily comprehended than three dimension drawings, to which it forms an appropriate stepping stone. Since Part I is entirely devoted to principle, it can only be reviewed on this basis, and judging from the thoroughness with which the author endeavors to impress principles, we shall look for Part 2 to give the pupil a better grounding in practical machine delineation than many works on mechanical drawing that have preceded it. The prime consideration for the successful draftsman is the ability to form a mental picture of the device or shape which he is endeavoring to lay out, and this work is compiled in a way that should stimulate this power.

NEW TRADE LITERATURE.

THE GRANT GEAR WORKS, INC., 6 Portlandt St., Boston, Mass. 1905 edition of their catalogue, containing their stock gear list, with prices, and some useful hints on gears, with tables and gear chart.

THE WHITMAN & BARNES MFG. CO., Chicago, Ill. Catalogue No. 56 of twist drills, reamers, taps, drop-forged and screw wrenches and cotters. Several sizes and styles of drill cases are shown, and also bit stock drill sets and a price list of the W. & B. warranted files.

F. A. ERRINGTON, 39 Cortlandt St., New York. Catalogue of the Errington automatic reverse tapping chuck, and leaflet describing an adjustable frictional opening stud setter. An improved duplex self-centering tap holder is now made for the chuck, which permits the tap to automatically align itself independent of the chuck.

THE R. D. NUTTALL CO., Pittsburg, Pa. Catalogue No. 9, January, 1905, of gears and pinions for mine and industrial machinery. Here are shown motor gears, motor pinions, haulage trolleys in great variety, machine gears and pinions, etc. The company expect to issue a very complete catalogue in the near future, their present one showing only some of the types.

THE INGERSOLL-SERGEANT DRILL CO., New York. Catalogue No. 52 of coal mining machinery. Air compressors, coal cutters, coal and rock drills, etc., are shown at work, and descriptions of each of the products appear, accompanied by half-tone illustrations. The catalogue should prove of interest to those having to do with mining machinery.

HAMMACHER, SCHLEMMER & CO., New York. Catalogue No. 262, presenting exclusively bolts, screws, nuts and supplies. This is 5 x 7 in size, bound in cloth, and illustrates and describes a great variety

MACHINERY.

April, 1905.

VARIABLE SPEED MOTORS.—11.

THE THOMPSON-RYAN VARIABLE SPEED MOTOR.

WM. BAXTER, JR.

In previous articles of this series we have shown that there are two difficulties that stand in the way of obtaining unlimited variation in the velocity of a motor. One of these is that the size of the machine increases as the range of speed increases, and the other that the difficulty of obtaining sparkless operation of the commutator brushes increases with the range of variation. In many cases the advantages derived from a speed variation of, say, ten to one, might be so great as to make it advisable to use a motor ten times as large as would be required for the higher velocity. If we undertake to accomplish this result with a two-wire system, that is, with a single voltage, we will find that it is not practical by the ordinary methods, even if we are willing to use a motor of the necessary size. The reason why it is not practical is that long before any such wide variation is obtained the sparking of the brushes will be so severe as to make the successful running of the motor impossible.

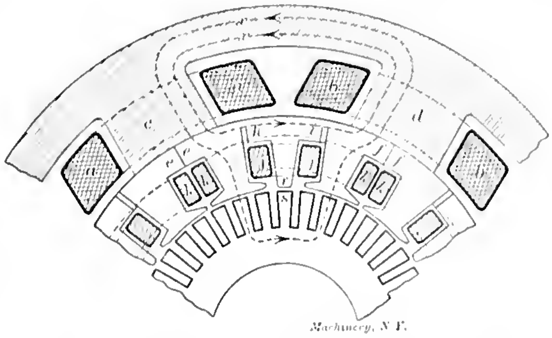


Fig. 1. Showing Principle of Operation of Thompson-Ryan Motor.

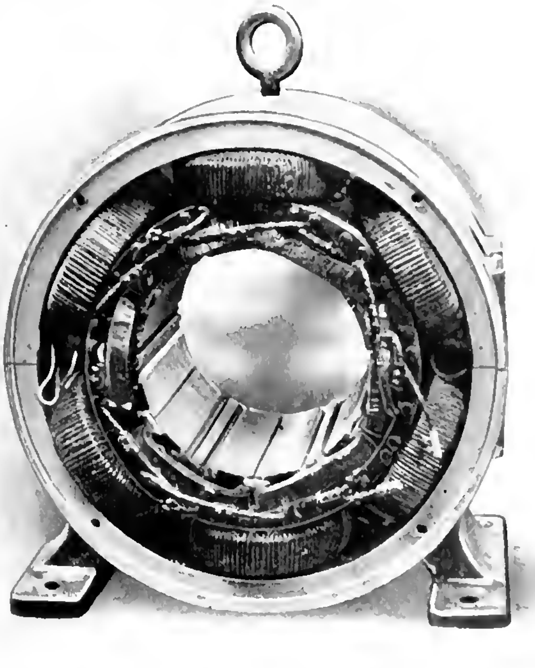


Fig. 3. View of the Field with Balancing Ring in Position

The reason why the sparking of the brushes prevents the attainment of a great change in velocity with a single voltage is that the change is obtained by reducing the strength of the field magnetism. The field magnetism, and the magnetism induced by the current flowing through the armature coils, are at right angles to each other, and a torsional force is set up between them. If the field magnetism is strong and that of the armature is weak, the former will not be drawn very far away from its natural position. If, however, the field magnetism is weak and that of the armature is very strong, the latter will predominate and as a result the field will be twisted around quite an angle from its natural position.

To secure sparkless running of the commutator brushes it is necessary that the armature coils connected with the segments passing under the brushes move through a magnetic field just strong enough to develop an E.M.F. sufficient to reverse the current in the coil and build up a current of the same strength flowing in the opposite direction, during the time the coils are short-circuited by the brushes. Such a field can be found at a point between the poles of the motor for a particular strength of field and armature current; but any variation in the strength of the motor field or the armature current will change the strength of the field at this point and cause sparking at the brushes. If the field remains unchanged, and the armature current varies, the field at the commutation point will vary directly through the change in the strength of the field developed by the armature current, and indirectly through the variation in the extent to which the field magnetism is diverted from its natural position. If the strength of the field magnetism is varied, the commutation field will be varied in consequence of the change in the angle through which the field magnetism is distorted by the reaction of the armature.

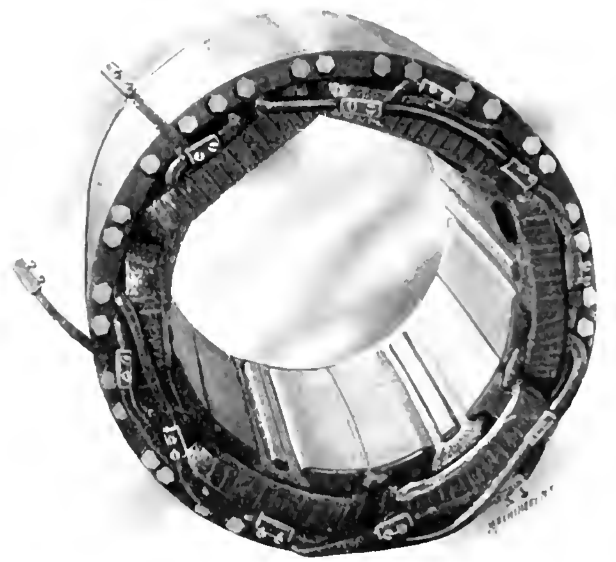


Fig. 2. Balancing Ring

If the strength of the armature current is not varied too much, or if the strength of the motor field is changed but slightly, the effect upon the action of the commutator brushes will be so small that it will not be noticeable; but anything more than a slight change will so increase the sparking of the brushes as to render the operation of the motor unsatisfactory.

How to Obtain Sparkless Commutation.

To obtain sparkless operation of the brushes, when the armature current and the field strength are varied through wide limits, it is necessary to provide means to entirely neutralize the distorting effect of the armature current upon the field magnetism, so that the direction of the latter may always re-

main the same, regardless of its strength; and further to provide a commutating field that is independent of the motor field and that will increase and decrease as the strength of the armature current increases and decreases. This result is fully accomplished in the Thompson-Ryan motor made by the Ridgway Dynamo & Engine Co., Ridgway, Pa. It is built upon the same principle as their generators, which have been in successful operation for many years.

Principle of Operation of the Thompson-Ryan Motor.

The principle of operation of this motor can be fully understood from the sketch, Fig. 1, which shows a portion of the field and armature and of a ring carrying some magnetizing coils, called a balancing ring, which is placed between the field and armature. The outer ring, shaded with section lines, is the field; *c* and *d* are the polar projections upon which the field magnetizing coils *aa*, *bb*, are placed, these being connected in shunt relation to the armatnre. The balancing ring is made up of sheet steel laminations, *h i r* and *e e*, *f f*. The latter named pieces form extensions of the polar cores *c* and *d*. A coil, *j j*, is placed around the small polar core, *r*, and another coil, *k k*, of larger size embraces one of the *c* and one of the *f* cores. Both these coils, *j j* and *k k*, are connected in series with the armature, so that the current passing through them at all times is equal to that passing through the armature, being the same current. The coils, *k k*, are so connected with the circuit that the current flows through them in the opposite direction to that flowing through the armature conductors immediately under them. Hence, the magnetizing action of the coils is directly opposed to that of the armature, and as they are properly proportioned to exactly balance the armature coils the effect is that the reaction of the armature upon the field is entirely neutralized, so that the path of the field magnetism is always that indicated by the lines, *x x*, no matter how weak the field may be.

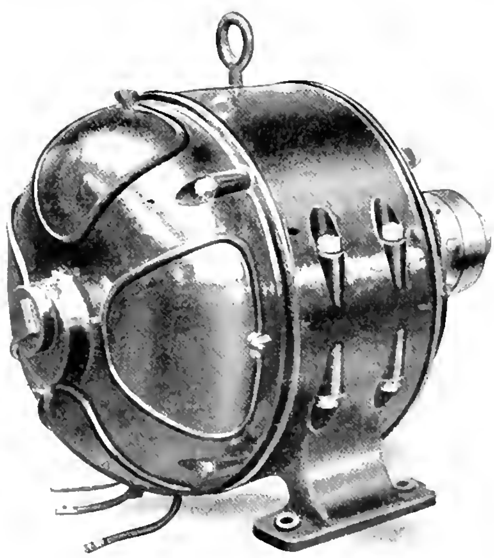


Fig. 4. Showing Motor Complete.

Action of the Coil J J.

The coil, *j j*, wound upon the core, *r*, develops a magnetic flux that passes through *s* and forms the commutating field. This coil, *j j*, is connected in series with *k k* and with the armature, hence, the magnetic flux developed by it rises and falls with the rise and fall of the armature current. This is just what is wanted to secure perfect commutation; for if the armature current is weak, the E.M.F. induced in the commutated coil must be small so as to not develop a current too strong; and, as the armature current increases, the E.M.F. induced in the commutated coil must increase, so that the commutating current may not be too weak. In theory it is possible to obtain perfect commutation by means of these balancing coils, provided the magnetization of the iron cores is not carried too high. In practice the degree of perfection attained depends wholly upon the accuracy with which the various parts are proportioned.

The actual appearance of the balancing ring is shown in Fig. 2. Fig. 3 shows the field with the balancing ring in position.

Effect of Balancing Ring on Size of Motor.

It might be supposed that the introduction of this balancing ring between the field and armature of the motor would result in materially increasing the size of the machine. Such, however, is not the case, as can be seen from Fig. 4, which shows a 7½ H. P. motor designed for a speed variation of six to one. Considering the range of velocities the size is not excessive.

The Thompson-Ryan Drum Type Controller.

The Ridgway Company make a drum controller for the operation of these motors. This controller is made either reversing or non-reversing. In addition to the contacts necessary

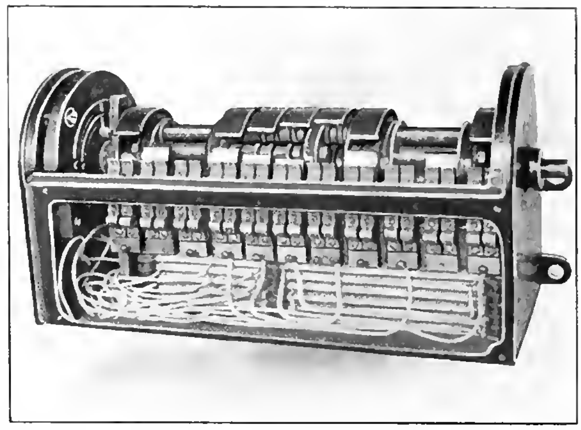


Fig. 5. Controller with the Casing Removed.

for connecting the motor with the circuit and for varying the speed, it has other contacts that are used to effect a quick stop whenever such is required. These contacts connect the armature in a closed circuit in which more or less of the starting resistance is included, after the connection with the line is broken; and thereby convert the motor into a generator for the time being, thus producing a dynamic brake effect. The controller, with the casing removed, is shown in Fig. 5. A row of stationary contacts connects with the rings mounted upon the drum, as the latter is rotated, and thus makes the necessary connections between the motor and the line to produce rotation in the desired direction and also to cut out the starting resistance from the armature circuit. At one end of the controller box are secured, in two circular rows, contacts that connect with the resistance that is introduced into the shunt field circuit of the motor to obtain the required increase in speed. The drum carries a pair of contacts connected with each other, but insulated from other parts, that ride over the field resistance contacts and thus cut in the sections of the latter.

Operation of the Controller.

The connections of the controller, and those between it, the motor and the line are well shown in the wiring diagram, Fig.

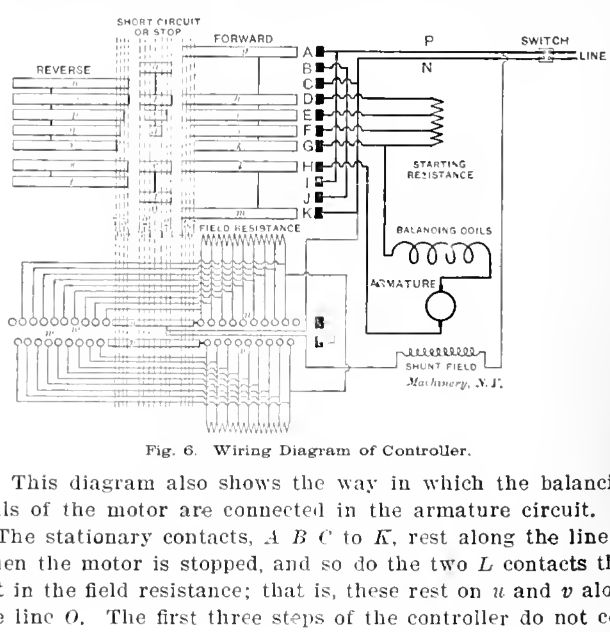


Fig. 6. Wiring Diagram of Controller.

6. This diagram also shows the way in which the balancing coils of the motor are connected in the armature circuit.

The stationary contacts, *A B C* to *K*, rest along the line *O* when the motor is stopped, and so do the two *L* contacts that cut in the field resistance; that is, these rest on *u* and *v* along the line *O*. The first three steps of the controller do not con-

nect the motor with the line; these are used only in stopping and are provided so as to cut in all or only a portion of the starting resistance, according to the rapidity with which it is desired to stop. In starting the motor the operation is as follows:

Suppose it is desired to run in the forward direction, then the controller is turned to the right to the fourth step, and this movement will slide ring g under contact A, ring h under contact D, ring l under contact H and ring m under contact K. As rings g and h are connected with each other, the current from line wire P will pass to D and thence through all the starting resistance to the balancing coils, through the latter to the armature, and through this to contact H. As H rests on l, and the latter is connected with m, the current passes to K and thence to line N. The current for the shunt field of the motor passes from line N to and through the field coils to contact v, and as this contact is connected with u through the two contacts L the current can find its way to line N just beyond contact K. When the controller is advanced to the fifth step drum ring i slides under contact E, and thus one section of the starting resistance is cut out. On the sixth step, drum ring j slides under contact F, thus cutting out the second section of the starting resistance. On the seventh step ring k connects with contact G and all the starting resistance is cut out.

Further advance of the controller slides the two contacts L over the contacts w and thus the field resistance is cut in and the speed is increased until the maximum velocity is reached.

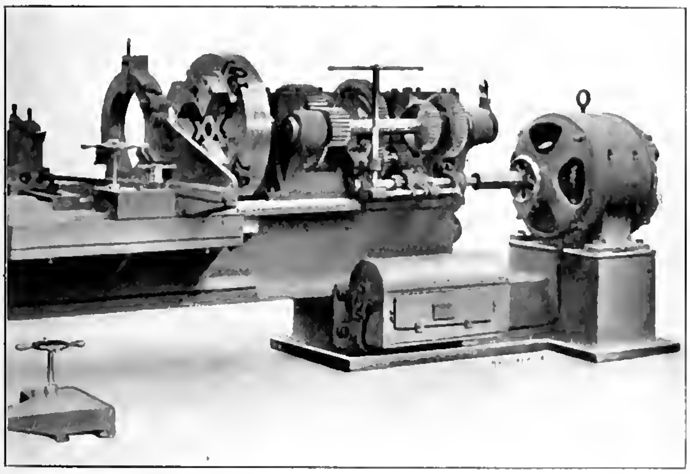


Fig. 7. Lathe Driven by a Thompson-Ryan Motor, showing Method of Connection.

On the seventh step the motor runs at its lowest velocity, 19 other speeds are obtained between this and the maximum velocity.

In stopping, if it is desired to make a slow stop, the controller is returned to a position between the fourth and the third steps. In this position the motor is entirely disconnected from the line. If a quick stop is desired, the controller is brought back to the third step and then drums contacts a and b connect stationary contacts B and D, while drum contacts e and f connect stationary contacts H and J. By tracing the circuit from B it will be found that it is to D, thence through the whole of the starting resistance to the balancing coils, through the latter and the armature to H and then to J and back to B. If the controller is moved back to the second step, B D and E will be connected by a b and c, so that one section of the starting resistance will be cut out. This will reduce the resistance against which the armature will have to generate a current; hence, the current will be stronger and the retarding effect greater. If the controller is returned to the first step, two sections of the starting resistance will be cut out and as a result the current generated by the armature will be still stronger, thus producing a still quicker stop.

The way in which the Thompson-Ryan motors are connected with machine tools is illustrated in Fig. 7, which shows one of these motors of 15 H. P. with a speed range from 350 to 1,750 connected with a 27-inch by 14-foot projectile-turning lathe, of Lodge & Shipley make.

NOTES ON RIVETED JOINTS.

WALTER RAUTENSTRAUCH

In "Special Topics on the Design of Machine Elements," by Prof. John H. Barr, we find the following equations concerning riveted joints:

$$d = \frac{4}{\pi} \cdot \frac{n\,k_1\,f_s + m\,k_2\,f_s^1}{n\,f_s + 2\,m\,f_s^1}\,t$$

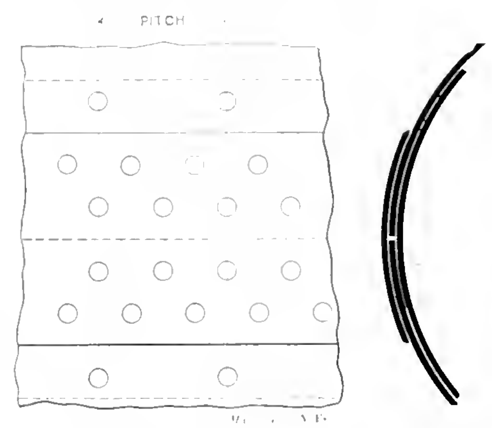
and

$$p = \frac{\pi}{4}\,d^2\left(\frac{n\,f_s + 2\,m\,f_s^1}{t\,f_t}\right) + d$$

where

t = thickness of plate
d = diameter of rivet } for maximum efficiency.
p = pitch of rivet
n = number of rivets in single shear per unit strip of joint.
m = number of rivets in double shear per unit strip of joint.
f_s = intensity of shearing stress in single shear rivets.
f_s^1 = intensity of shearing stress in double shear rivets.
f_t = intensity of tensile stress.
$k_1 = \frac{f_b}{f_s}$ where f_b = intensity of crushing stress in single shear rivets.
$k_2 = \frac{f_b^1}{f_s^1}$ where f_b^1 = intensity of crushing stress in double shear rivets.

It can readily be seen from the above equations that the diameter of rivet and also the pitch may be found when the form of the joint and the thickness of the plate are known.



Type of Joint used in the Calculations

The form of the joint can easily be determined for any case by comparison with those which usually exist in practice.

The thickness of the plate may be found as follows:

Let P = pressure in pounds per square inch.
D = diameter of boiler in inches, then

$$t = \frac{P\,D}{2\,E\,f_t}$$

where E = efficiency of joint.

In the same text cited above Prof. Barr gives the general expression for the efficiency of any joint whatever, as,

$$E = \frac{1}{1 + \frac{f_t}{n\,k_1\,f_s + m\,k_2\,f_s^1}}$$

which may be transformed to

$$E = \frac{n\,f_b + m\,f_b^1}{n\,f_b + m\,f_b^1 + f_t}$$

This expresses the efficiency for equality of shearing, crushing and tearing strengths.

Substituting the value of E thus found in the equation for the thickness, we have

$$t = \frac{P\,D\,(n\,f_b + m\,f_b^1 + f_t)}{2\,(n\,f_b + m\,f_b^1)\,f_t}$$

If there are no rivets in double shear, the equation becomes

$$t = \frac{P\,D\,(n\,f_b + f_t)}{2\,n\,f_b\,f_t}$$

and if there are none in single shear it becomes

$$t = \frac{P\,D\,(m\,f^1_b + f_t)}{2\,m\,f^1_b\,f_t}$$

Thus for any joint whatever, whether the rivets are in single or double shear, or both, when the form of joint is decided upon, the thickness of plate can be determined. Then by substituting the value found for the thickness, and by introducing the proper value for the other members of the equations for pitch and diameter of rivets—these values depending on the form of joint—the pitch and diameter of rivet may be found.

To illustrate, let it be proposed to design the longitudinal seam of a boiler whose diameter is 60 inches and which is to carry a pressure of 200 pounds per square inch. The first step will be to decide on the form of the joint. Let it be a double riveted butt joint with an inside cover plate, having 4 rivets per unit strip in double shear and 1 rivet in single shear, as shown in the figure.

Let $f_b = 60{,}000$. $f_s = 36{,}000$.
$f^1_b = 72{,}000$. $f^1_s = 32{,}000$.
$f_t = 50{,}000$. factor of safety $= 5$.

Substituting in the equation for thickness of plate, we have

$$t = \frac{200 \times 60\ (60{,}000 + 288{,}000 + 50{,}000)}{2\ (60{,}000 + 288{,}000)\ 50{,}000} \times 5 = .68'' = \tfrac{11}{16}''$$

and in the equation for diameter of rivet we have

$$d = \frac{4}{\pi} \times \left(\frac{1.66 \times 36{,}000 + 4 \times 2.25 \times 32{,}000}{36{,}000 + 8 \times 32{,}000}\right) \times .68 = 1''$$

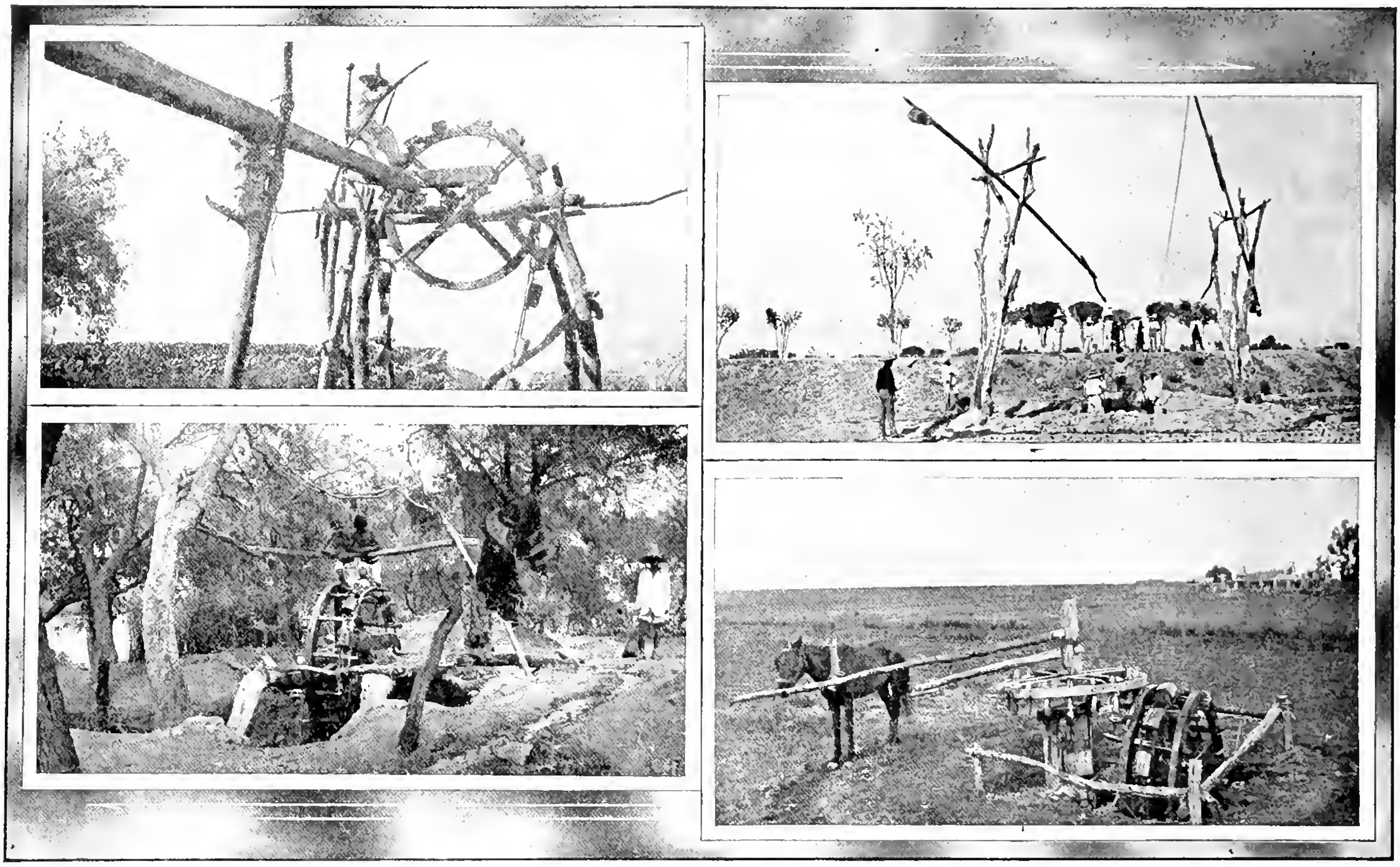
and for pitch of rivet, we have

$$p = \frac{\pi}{1}\left(\frac{36{,}000 + 8 \times 32{,}000}{.68 \times 50{,}000}\right) + 1 = 7\tfrac{3}{4}''$$

The above is to be understood as applying only to the design of joints for maximum efficiency, *i. e.*, when the efficiencies in shearing, crushing and tearing are all equal. The values of t, d, and P, given above, were derived by equating the strength in shearing, crushing and tearing.

PUMPING IN MEXICO.

The accompanying photographs, loaned to us by Henry R. Worthington, 114 Liberty Street, New York City, were taken in Southern Mexico, and show the methods in general use there for elevating water. The patents on these devices have doubtless long since expired and we feel, therefore, perfectly safe in giving them out to the public. The Worthington Company write, "We might add that it is to be observed, in the way of comparisons, that one of the man-and-wheel pumps seems to develop a very much higher duty than the other, from the fact that, whereas in one case a single man keeps the thing going with his 'shirt on,' in the other case two men without shirts, or much of any other clothing to speak of, are required. The dreams of these 'high-drawlick' engineers are certainly never troubled by visions of that Old Man of the Sea of the modern engineer, the question of fuel consumption."



Pumping by Ancient Methods in Mexico.

It is interesting to know that these ancient devices are being rapidly replaced by more effective machines of modern type and that Worthington irrigation pumps of the new turbine pattern are coming into very extensive use in Mexico, where power is cheaply developed by utilizing the many mountain streams for generating electric current, and then distributing it over the vast agricultural areas lying between the mountain chains.

* * *

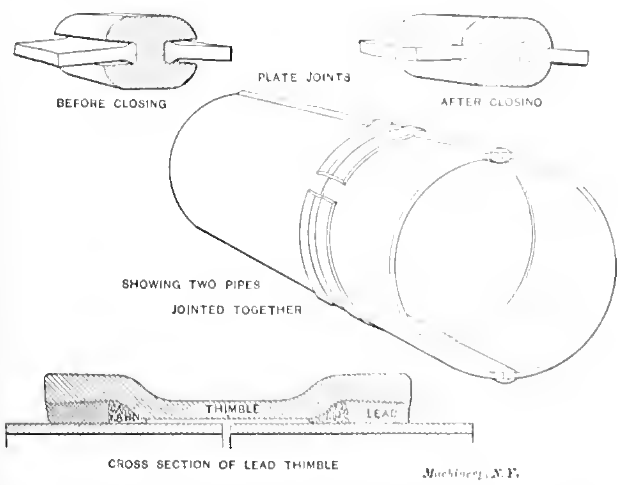
There have been a number of very interesting experiments carried on recently to ascertain the relative economy of the different sizes of coal used on locomotives. These were made in a so-called Wooten firebox and proved conclusively that even with this size grate the larger coal was more economical. This is rather hard on the advocates of the alleged "dirt burners" which were destined to revolutionize the railroad field a few years ago, if their stories were to be believed. Tested in a firebox better suited to its needs the larger coal will make a much better showing and bear out the contentions of those who have always claimed that the economy of the dirt burners was imaginary and in reality existed on the other side of the ledger. These go to prove that some of the fads of design and practice in railroading are likely to be short-lived if the managers are really after the most economical operation of the roads.

CONSTRUCTION OF THE COOLGARDIE PIPE LINE.

A remarkable engineering feat has been performed in Australia, of which the world has heard very little, and that is the carrying of a pipe line from the western coast to the Coolgardie gold fields, a distance of 363 miles in direct line from the port of Fremantle. Gold was discovered in this region in 1892, but the great scarcity of water made working of the mines practically impossible, the average rainfall being only slightly over 7 inches, and the climate being almost tropical in summer. It was first attempted to obtain water by boring, but after wells over 3,000 feet deep had been driven through granite without finding water in paying quantities, the attempt was given up. It was then proposed to carry a pipe line from the coast and this scheme was finally adopted in 1895. The enormous cost of the project, principally due to the large amount of pipe required, made the design of the pipe itself one of the first importance. Its diameter is 30 inches, and it is made of steel boiler plate in sections 28 feet in length. It was required to stand a hydraulic test of 400 pounds per square inch, and it is clear that the design of longitudinal joint which most nearly approached in strength that of the solid plate would be the most advantageous, other things being equal.

After a series of tests, the construction embodying the Mephan-Ferguson locking-bar joint was selected. This remarkably simple construction makes the joint of practically 100 per cent efficiency, that is, the joint is as strong or even stronger than the solid plate itself. With this joint it was possible to make the pipes of steel plate only ¼ inch thick, save in some portions of the line, as at the bottom of deep valleys where heavier pressures existed, and in these parts the pipes were made of plates 5-16 inch thick, but even with pipes of the average thickness of only ¼ inch, the total estimated weight of steel plate required for the line is something like 76,000 tons.

As will be seen from the accompanying illustration, each



Joint for Longitudinal Seams of Pipe, having an Efficiency of nearly 100 per cent.

pipe is made up of two steel plates rolled into semi-circular form, the edges of the plates being upset by a special upsetting press, and then the locking-bar is forced on, appearing as shown in the view designated "before closing." The sides of the locking-bar are then closed upon the sheets by powerful hydraulic machinery, making a hermetically sealed joint, which, as stated, is as strong or stronger than the solid plate. This type of joint has the additional advantage over riveted joints that there are no rivet heads projecting into the interior of the pipe to retard the flow; the locking-bars being arranged longitudinally offer practically no retarding effect to the flow, save the reduction in cross section which is very slight. The connection between the pipe ends is formed in essentially the same manner as is ordinarily employed with cast-iron water pipes. It is composed of a forged steel sleeve, bell-mouthed at the ends as shown in the cross section. A soft packing of yarn or oakum is first rammed in, and then lead is poured and calked in place by a hydraulic press. To preserve the pipe line from corrosion, each pipe was immersed in a bath of hot asphalt, and kept there until the steel had attained the same temperature as the bath. There are twenty pumping stations distributed along the line. It is worthy of note that one half the pumping engines (twenty in number [illegible]t by the Worthington Company, and are of the triple-expan[illegible]n surface-condensing, high-duty type. Twelve of these en[illegible]s for stations 1 to 4, each pump 1,945 imperial gallons per minute against a head of 450 feet, and eight of the engines, for stations 5 to 8, each pump 3,890 imperial gallons per minute against a head of 225 feet. The contract provided that the efficiency of these engines should be measured by a duty of 135,000,000 foot-pounds per 1,000,000 B. T. U. Upon the official tests the engines performed a duty of 142,931,000 foot-pounds per 1,000,000 B. T. U. All the boilers for the stations are of the Babcock & Wilcox make, working under a pressure of 175 pounds per square inch. For the facts in the above we are indebted to an interesting article which appeared in the March issue of the *Canadian Engineer*.

* * *

PROGRESS ON THE PENNSYLVANIA TUNNEL.

Work is well under way on the tunnels under North and East rivers, by which the Pennsylvania Railroad will enter New York City. Compressed air is to be used very extensively in the pushing of the immense tubes under the rivers and the compressor plants will represent the latest developments of pneumatic practice. The contracts for the air-power equipments were awarded to the Ingersoll-Sergeant Drill Co., New York, who are now installing the machinery.

The work is to be carried on in two distinct sections and under separate contracts. The larger of these, for tunneling under the East River—secured by S. Pearson & Son, Inc.—provides for building four parallel tubes between Long Island and Manhattan, each to be 33 feet in diameter. The work is to be pushed from both ends at the same time.

The four power plants being installed for the work represent in the aggregate the largest installation of air-compressing machinery ever made for general power purposes, and every refinement has been applied which could contribute to economy and reliability, for when the work is once under way no interruptions can be permitted. The main air-compressing plants on the East River tunnel will include twelve Ingersoll-Sergeant cross-compound Corliss steam-driven compressors, with duplex air ends of the latest type. Eight of these are low-pressure units, each with a capacity of 5,000 cubic feet of free air per minute, compressed to 50 pounds from atmospheric intake. This air is to be used for keeping out the water and mud when the shields are driven forward. There will be two high-pressure compressors designed to draw their intake either from atmospheric or from the discharge of the low-pressure machines. In the former case the capacity is 1,500 cubic feet of free air compressed to 100 pounds; in the second case it is from 2,000 to 6,600 cubic feet delivered at pressures up to 150 pounds. This high-pressure air is to be used for running rock drills, driving concrete mixing machines, and possibly for pneumatic haulage. The remaining two units are combination compressors having steam cylinders coupled in tandem to two pairs of duplex high and low-pressure air cylinders. Either set of compressing cylinders may be thrown into operation, the machines thus serving as reserve units for either the high or low-pressure compressors.

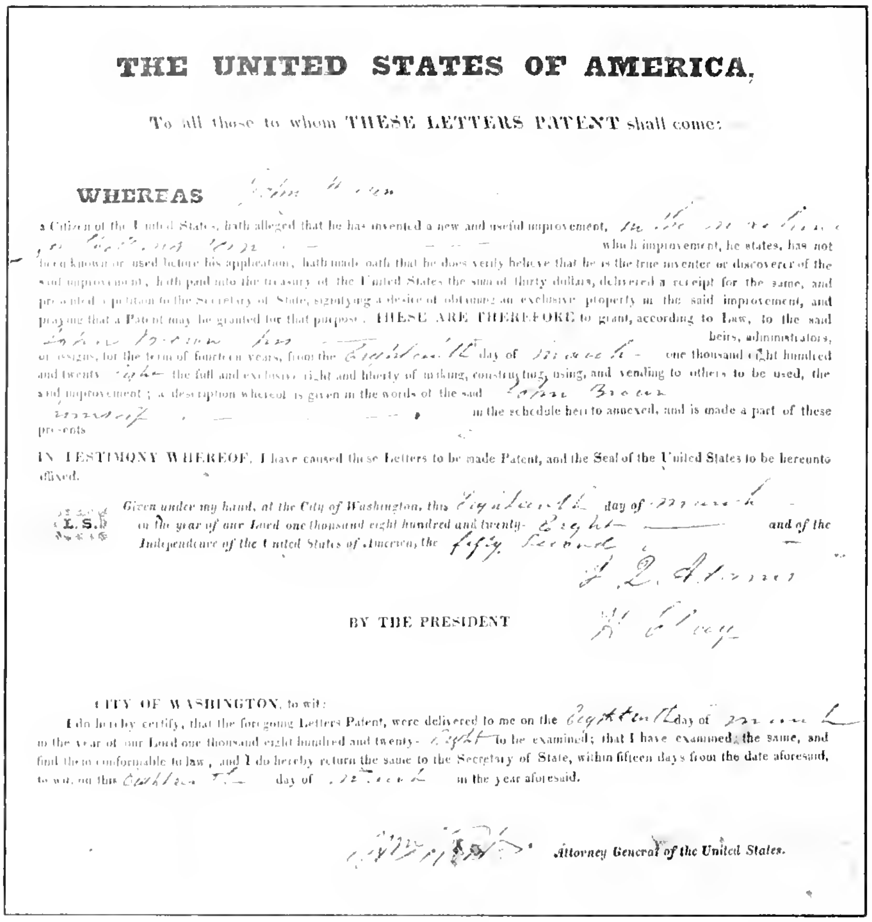
The contract for the North River tunnel is not so extensive there being only two tubes to be built, of 33 feet diameter. The machinery for this also is being installed by the Ingersoll-Sergeant Drill Co. Eight compressor units are to be used, four on each side of the river. These are of the steam-driven, cross-compound Corliss type, with duplex air ends, six being low-pressure machines and two high-pressure. The air is to be used for the same purposes and in the same manner as in the East River tunnels.

* * *

A revival of American machine exports to Germany is reported by Consul-General Mason, of Berlin, the exports of machine tools for 1904 being 1,634 metric tons as against 724 metric tons in 1903. Equally as great improvement is noted in the case of sewing machines, pumps, typewriters, electric machines, etc. Mr. Mason says that it is because American manufactured articles are well known and appreciated in Germany that the demand for them has recovered and kept pace with the general revival of prosperity in that country.

COPY OF A PATENT ISSUED IN 1828.

In 1828 John Quincy Adams was president of the United States and Henry Clay was secretary of State. Among the important duties that these gentlemen had to perform in carrying out the business of the government was the signing of patent papers issued to inventors. One of the patents taken out in this year and signed by the president and his first adviser was issued to a certain John Brown and the specifications are here reproduced, by means of the half-tone plates and the text printed on the next page. The patent itself was about as ordinary as the name of the inventor and related to a corn-shelling machine which consisted of nothing more nor less than a hole in a board or other flat surface, having expanding sides and through which ears of corn were to be driven by means of a mallet scraping away the kernels.


THE UNITED STATES OF AMERICA,

To all those to whom THESE LETTERS PATENT shall come:

WHEREAS John Brown

a Citizen of the United States, hath alleged that he has invented a new and useful improvement, [illegible] which improvement, he states, has not been known or used before his application, hath made oath that he does verily believe that he is the true inventer or discoverer of the said improvement, hath paid into the treasury of the United States the sum of thirty dollars, delivered a receipt for the same, and presented a petition to the Secretary of State, signifying a desire of obtaining an exclusive property in the said improvement, and praying that a Patent may be granted for that purpose: THESE ARE THEREFORE to grant, according to law, to the said John Brown his heirs, administrators, or assigns, for the term of fourteen years, from the Eighteenth day of March one thousand eight hundred and twenty eight the full and exclusive right and liberty of making, constructing, using, and vending to others to be used, the said improvement; a description whereof is given in the words of the said John Brown himself in the schedule hereto annexed, and is made a part of these presents.

IN TESTIMONY WHEREOF, I have caused these Letters to be made Patent, and the Seal of the United States to be hereunto affixed.

L. S. Given under my hand, at the City of Washington, this Eighteenth day of March in the year of our Lord one thousand eight hundred and twenty-Eight and of the Independence of the United States of America, the fifty Second.

J. Q. Adams

BY THE PRESIDENT H. Clay

CITY OF WASHINGTON, to wit:

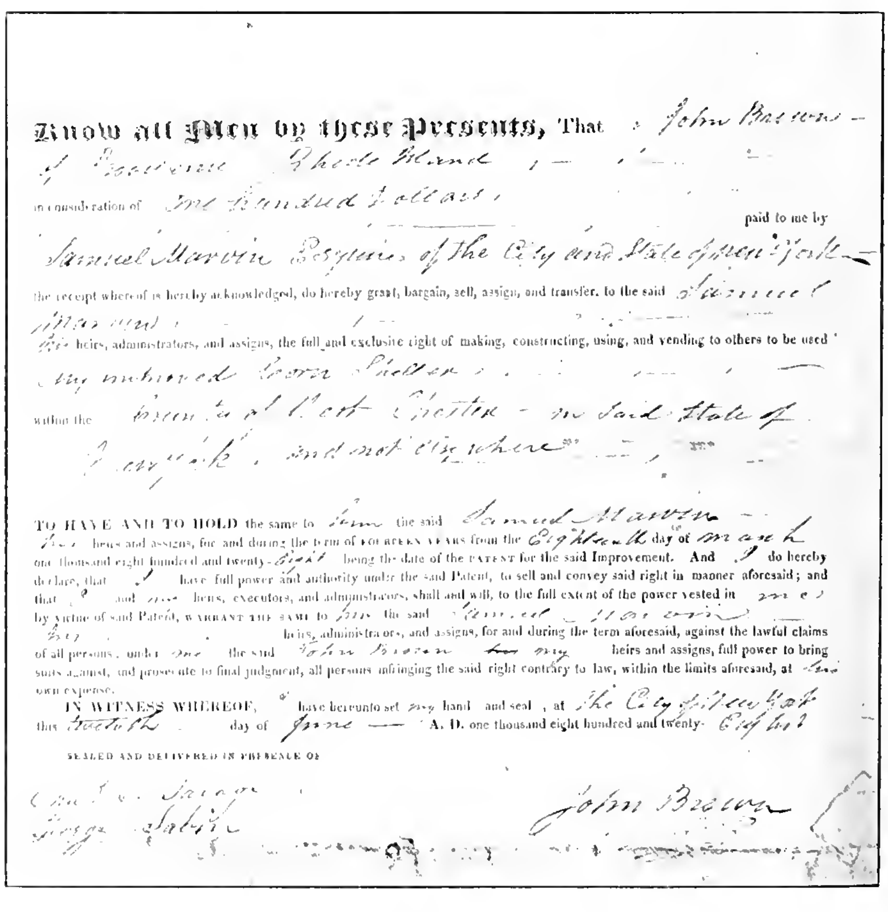
I do hereby certify, that the foregoing Letters Patent, were delivered to me on the Eighteenth day of March in the year of our Lord one thousand eight hundred and twenty-Eight to be examined; that I have examined the same, and find them conformable to law, and I do hereby return the same to the Secretary of State, within fifteen days from the date aforesaid, to wit, on this Eighteenth day of March in the year aforesaid.

[illegible] Attorney General of the United States.

Fig. 1. First Page of Patent Specification, signed by John Quincy Adams and Henry Clay.

It can hardly be imagined that Theodore Roosevelt or John Hay, in fulfilling the duties of their high offices, should devote much time to matters so trivial as patents upon corn-shelling machines. The development of the country and of its many interests, both foreign and domestic, call for other work on the part of the chief executive. The establishing of our patent system, however, in the early days of our government was an event that has had as much to do with the industrial success of the country, and the organization of our great industrial enterprises as any other one thing. Protection to inventors, by means of the patent system at once led to a feeling of confidence on their part that their rights would be protected, and the organization of a patent system was of as great national importance in 1828 as the building of the Panama Canal is in 1904. It was quite right, therefore, that the highest officers of the government should give this subject their personal attention, even though it led in some instances to the trivial duty of signing patent papers like the one reproduced herewith.

The patent system of the United States was organized in 1770, but it was not until 1836 that the system practiced as it is to-day was inaugurated. Prior to 1836 there was no critical examination of the state of the art preliminary to the allowance of a patent application. The first patent granted by the Government was to Samuel Hopkins in 1780, for an improvement in pot and pearl ash manufacture. The last patent granted in 1889, at the close of the first hundred years of patents issued, was for an electromagnetic typesetting machine. These two patents are suggestive of the progress of the century. We are able to reproduce this early patent paper through the kindness of Mr. H. K. Harring, Ossining, N. Y., who sent it to us for publication. The document was made out on a four-page sheet, the first and second pages of which are shown in Figs. 1 and 2. The matter written on the last two pages is given in what follows:


Know all Men by these Presents, That John Brown of Providence Rhode Island

in consideration of One hundred Dollars, paid to me by Samuel Marvin Esquire of the City and State of New York

the receipt whereof is hereby acknowledged, do hereby grant, bargain, sell, assign, and transfer, to the said Samuel Marvin his heirs, administrators, and assigns, the full and exclusive right of making, constructing, using, and vending to others to be used my improved Corn Sheller

within the [illegible] in said State of [illegible], and not elsewhere

TO HAVE AND TO HOLD the same to him the said Samuel Marvin his heirs and assigns, for and during the term of FOURTEEN YEARS from the Eighteenth day of March one thousand eight hundred and twenty-Eight being the date of the PATENT for the said Improvement. And I do hereby declare, that I have full power and authority under the said Patent, to sell and convey said right in manner aforesaid; and that I and my heirs, executors, and administrators, shall and will, to the full extent of the power vested in me by virtue of said Patent, WARRANT THE SAME to him the said Samuel Marvin his heirs, administrators, and assigns, for and during the term aforesaid, against the lawful claims of all persons, under me the said John Brown [illegible] my heirs and assigns, full power to bring suits against, and prosecute to final judgment, all persons infringing the said right contrary to law, within the limits aforesaid, at his own expense.

IN WITNESS WHEREOF, I have hereunto set my hand and seal, at the City of New York this twelfth day of June A. D. one thousand eight hundred and twenty-Eight

SEALED AND DELIVERED IN PRESENCE OF

[illegible]

George [illegible]

John Brown

Fig. 2. Second Page of Specifications.

The Schedule Referred to

IN these Letters Patent and making part of the same, containing a description, in the words of the said JOHN BROWN himself of his improvement in the MACHINE FOR SHELLING CORN.

To all persons to whom these presents shall come, John Brown, of Providence, State of Rhode Island, gentleman, sends greeting. Be it known that I, the said John Brown, have invented, constructed, made and applied to use a new and useful improvement in a machine for shelling corn, specified in the words following to-wit:

My improvement is to drive the ear of corn or cob thro' holes, with a mallet or any other suitable apparatus. These holes may be in hard wood or metal, the latter is preferable for durability. The holes may spread or open by sections, and when the cob is driven in, those parts or sections may be driven back by springs, or any method may be adopted, as to the form and construction of the holes which an ingenious mechanic may think best to effect the same object. I prefer the following method, to-wit: Take a plate of cast iron about one foot in length, three inches in width and half an inch thick, with five or more holes of different diameters, with a ridge round the holes rising about one-quarter of an inch above the surface of the plate in a conical form. This plate is attached to a bench similar to a carpenter's saw bench, by which the ear of corn is held in a vertical position while driving through the hole with the right hand at the same time replenishing the ear with the left hand. I drive the small end of the ear "or cob" in a smaller hole from one to three or four inches before it enters the hole intended to pass thro' as the shape of the ear may require. It will be understood the corn flies off above the holes in said plate. A piece of coarse cloth resting on wire is attached to the end of the bench round the plate of iron to prevent scattering the corn, by which it is guided to a basket and the cobs separated, or the corn may pass into a coarse wire sieve or riddle. A small room, or partition in the corner of a room, may be substituted for the cloth round the iron plate above mentioned. Both may be dispensed with in warehouses where scattering the corn can do no injury. * * *

The advantages of this machine over others for shelling corn are cheapness, durability and simplicity, requiring no repairs, and if most convenient the labour only of children. I claim the application of driving the ear of corn or cob thro' holes as above described. In testimony that the above is a true specification of my said improvement as above described I have hereunto set my hand and seal, this twenty-seventh day of February, A. D., in the year one thousand eight hundred and twenty-eight. (Signed) JOHN BROWN.

Witness: John Barton, Philip Green.

* * *

THE PANAMA CANAL.

At the monthly meeting of the American Society of Mechanical Engineers for March, held at their New York house, Mr. W. R. Warner, of the Warner & Swasey Co., Cleveland, gave a talk on the Panama Canal. Mr. Warner recently accompanied a commission of congressmen on a trip to Panama, he, however, going simply as a private citizen. His opportunities for observation were, of course, unusual and, as might be expected, the love for investigation which characterizes the trained engineer, led him to inquire into many interesting facts that he related in an anecdotal way, affording much pleasure to the large audience that filled the hall. Mr. Warner is strongly in favor of a sea-level canal. It appears that if a canal with locks should be constructed, having a summit level of 85 feet elevation, as originally planned, an immense dam must be built at Bohio, across the valley in which the Chagres river flows, thus forming a lake at the water level of the highest lock in the system. This dam would have to be 2,000 feet long and under the best of conditions would be a great undertaking. Recent borings, moreover, show that the foundations would have to be carried about 150 feet below sea level, thus greatly increasing the obstacles in the way of its construction. After the dam was built and the canal finished, on the basis of 85 feet elevation, it would not prove satisfactory for all time and eventually the work would have to be undone and a sea-level canal finally built.

In the case of a sea-level canal the Chagres river, which crosses the path of the canal, would be controlled by a less expensive dam at another point on the Isthmus, and its channel diverted.

Drawings showing a cross-section of the Isthmus, and the proposed canal, it was pointed out, are often misleading to the casual observer because they are drawn to so contracted a longitudinal scale and so large a vertical scale that they give the impression of immense depths to be cut through an extremely mountainous region. As a matter of fact the greatest depth at the Culebra cut, where the most extensive diggings have to be made, is 275 feet, which the French company in their operations reduced to 150 feet. The dimensions of the canal, as laid out by the French company, were smaller than at present considered, so that some cutting would have to be done from the total height of 275 feet down to the 150-foot level, in order to secure the requisite width of canal. The point made by Mr. Warner, however, is that the amount of digging to be done is not so great as is generally supposed, and with modern machinery it is entirely possible to complete the canal at sea level within 10 or 12 years.

This result, if accomplished, will be due largely to the great efficiency of the modern American steam shovel. There are now three such shovels at work on the Isthmus, with a view to determining the amount of excavating that can be accomplished with them in a given time, and it is found that whereas previous estimates have been for a cost of 80 cents per cubic yard of material removed, present estimates based on the work of these machines are at the rate of 50 cents per cubic yard. The shovels are able to do much more than was anticipated, and the added cost of a sea-level canal over the estimate of the previous commission which investigated the subject, for a canal having a summit level of 85 feet elevation, is less than \$80,000,000—not a large sum when it is considered that New York State alone is preparing to spend \$100,000,000 for its canal. It is proposed to add more shovels at frequent intervals until 100 have finally been set to work. The chief difficulty in excavating will be in disposing of the material, which must be done by means of cars and temporary lines of tracks.

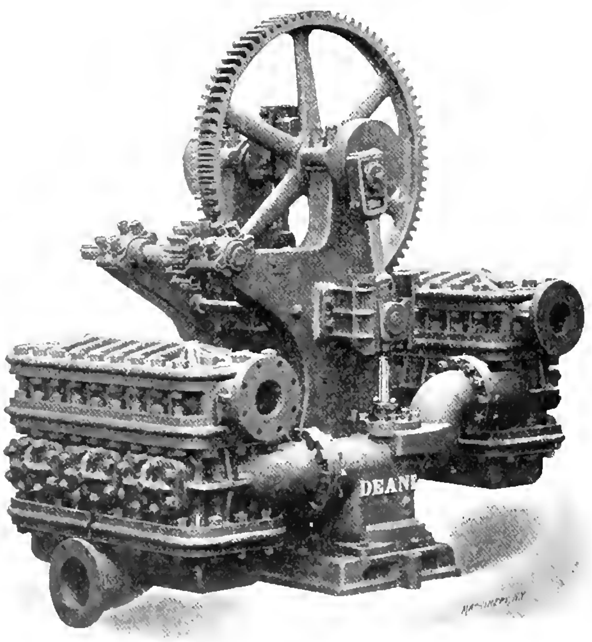
There is a force of several thousand employes of the government now at work on the Isthmus, this force including the medical staff, sanitary commission, etc., as well as the workmen and engineers.

Among the many interesting photographs thrown on the screen by Mr. Warner were several of the French excavating machines that had been left to rust for twenty years, since the work was begun by them. It is a sad sight to see literally miles of what was finely-built machinery in almost a hopeless state of ruin. Nearly all the French excavators are built on the plan of dredging machines having an endless chain of scoops which remove the dirt, mud or other material continuously instead of intermittently, like the steam shovels. For the removal of earth and broken stone this type is much less efficient than the shovel, but for removing mud and soft earth it is even more efficient than the shovel, so that it is the intention to repair many of the French machines and use them for taking out the soft material from the sides and bottoms of the parts of the canal already excavated.

Following Mr. Warner's talk Prof. Burr of Columbia University, a member of the Panama commission, and who had just returned from the Isthmus, gave an interesting statement on the subject, which of course was authoritative. Among other facts he told the inside history of the original recommendation of the former commission, of which he was a member, in favor of the Nicaraguan route. While from the engineering standpoint the Panama route was preferred the French company existing at that time made a demand for more than twice what the commission believed to be a fair estimate of the value of the property. The obvious way to accomplish a settlement on a more reasonable basis was to recommend another route which, if adopted, would destroy absolutely the value of the Panama property. This was done, whereupon the French company was reorganized and the new officers were very willing to accept the \$40,000,000 proposed by the United States as compensation.

PUMPING HEAVY FLUIDS.

In many industries it is necessary to force heavy, viscous liquids through pipes, which involves difficulties not encountered in ordinary pumping, and requires machinery special in design and construction. When the liquid is heavy, but not adhesive, as in the case of heavy oils, the action can be made fairly efficient by enlarging the valve openings, making the parts of the pump heavier, and so arranging the passages that there is little likelihood of choking or clogging. When, however, the liquid is a fluid at high temperatures, but a gelatinous adhesive paste or a rubbery solid, clinging to all surfaces and choking openings through which it should pass, as the temperature is lowered, a design differing materially from the ordinary pump must be used. Tar, molasses, and cocoa liquor present more obstacles to pumping than any other substances which it has been found feasible to move in this manner. Each of these liquids thickens into an almost solid mass when cold, rendering it very difficult to start the pump, unless some special provision is made and ample power provided. Another action which must be taken into account is the contraction of the area of the passages and valves as the liquid cools and the consequent throttling which interferes with the liquid's passage and which the pump is forced to overcome. The skin friction of a liquid of this kind creates heat enough to partially alleviate this tendency to throttling when the velocity of the substance is maintained above a certain point and the pipe is in such a position that the surrounding air will not lower the temperature of the liquid below the solidifying point. Although not a common practice, it is well to lag all exposed piping used for conveying heavy oils or other substances of a similar nature.



Special Pump for Heavy Fluids.

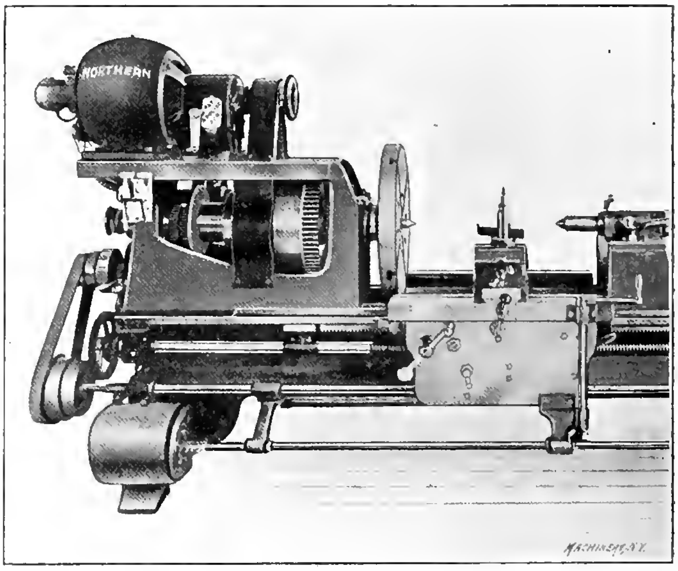
A liquid peculiarly difficult to handle is oil-refinery tar, which is usually very hot when it reaches the pump. There is a large percentage of suspended particles of various sizes present in this tar and also a certain amount of unrefined paraffin. The tar is sometimes heated to a temperature of 300 degrees, but quickly cools off if not properly handled, coating the retaining valves and walls with layers of an adhesive substance closely resembling finely divided particles of coke. To overcome this the ordinary pump arrangement is materially changed. The cut shows a pump installed by the Deane Steam Pump Co., Holyoke, Mass., for handling oil-refinery tar at the works of the Atlantic Refining Co., in Philadelphia. By a new arrangement, large valve areas are made available, designed to permit the passage of the substance pumped with the least possible frictional resistance. The suction, discharge, and pulsation chambers can be taken apart without unnecessary expenditure of time or labor, and each is in a position where it can be readily reached for cleaning. The pump is of the triplex type, fitted with ball valves which thorough test has proved best adapted for the passage of heavy substances. There are a number of large handholes for cleaning the valves. The figure shows the rigid crosshead guide system and the strong design of the chambers, rods, pistons, and bearings.

* * *

MOTOR DRIVES FOR OLD TOOLS.

The conversion of existing machine tools from the belt-driven into the individual motor-driven type, with the least expenditure of time and labor, is a problem apparently solved in the case of the lathe shown in the accompanying illustration. The Northern Electrical Mfg. Co., Madison, Wis., have taken this problem definitely in hand, and adapted one of their types of motor to the service. The change made consisted in the addition of a special bonnet or end case, containing a change gear device, to the motor.

The cut below shows a 24-inch engine lathe, which the Northern Electrical Mfg. Co. equipped with a motor in place of the belt drive formerly used with this machine. To make this change the bearing caps of the spindle bearings were taken off, and a saddle designed to rest on the spindle bearing housings, to span the cone, fastened in place. Upon this saddle, which now formed part of the spindle bearings, the motor equipment was installed. The cones were left in place, and a split gear clamped to the second largest cone. The spindle is driven from the motor pinion through a silent chain to the split gear on the cone.



Old Lathe of Standard Design Fitted with Motor.

The motor used is the Northern multi-speed, which supplements the electrical speed variations secured by the motor winding by the gear ratio supplied by the change gears. In this case the variation is of about 7 to 1. The total number of speeds depends of course upon the number of points in the controller; in this case the controller has twenty points. There are available, then, twenty speeds through motor direct, twenty more by using the change gears, and, as back gears of the lathe may be used with any of the above forty speeds, eighty in all, whereas the original belt drive allowed only eight. The spindle speeds of the lathe now range from 3½ revolutions per minute to 330 revolutions per minute.

The lathe speeds are controlled through two levers. Of these the one at the right end of the lathe apron, actuating the controller, is commonly used. It operates through the medium of the bevel gears and the splined horizontal rod, as shown. The other lever, which manipulates the change gears, is only used when the controller cannot produce the speed required.

Gears and clutches run in oil. The motor used with this system takes current from a two-wire direct-current circuit. While the motor here used is variable speed, a constant speed motor could of course be used if only two speeds were required. These could be obtained through the change gears, a change being made without the necessity of stopping the machine.

NEW PLANT OF THE RIDGWAY MACHINE TOOL CO.—A 10-16 FOOT BORING MILL THE FIRST TOOL PRODUCED.

Mr. L. H. Morgan, Superintendent and General Manager.

THE Ridgway Machine Tool Co., Ridgway, Pa., was organized about two years ago for the manufacture of heavy machine tools, such as boring mills, planers, engine lathes, driving wheel lathes, etc. On January 11 last the first machine was completed and shipped. It was a 10-16-foot extension boring mill of massive construction, designed for use with high-speed steels, and was shipped to the Bucyrus Co., South Milwaukee, Wis., for work upon the heavy machinery which this concern is building for the Panama Canal.

In the interval between the organization of the company and the first shipment a large and modern plant has been constructed and equipped with new tools, a considerable number of patterns are already completed for various machines, and there are now 150 men employed, with orders enough ahead to keep this force busy for twelve months.

The new company is controlled entirely by local capital, which speaks well of the prosperity of the community and of the enterprise of its citizens. The officers of the company comprise the following gentlemen: H. R. Hyde, president; P. R. Smith, vice-president; R. J. Powell, secretary, and E. C. Powell, treasurer. The superintendent and general manager of the Ridgway Machine Tool Co. is Mr. L. H. Morgan, for many years with the Pond Machine Tool Co., Plainfield, N. J. The head draftsman and engineer is Mr. F. B. Cockburn, also formerly connected with the Pond Company.

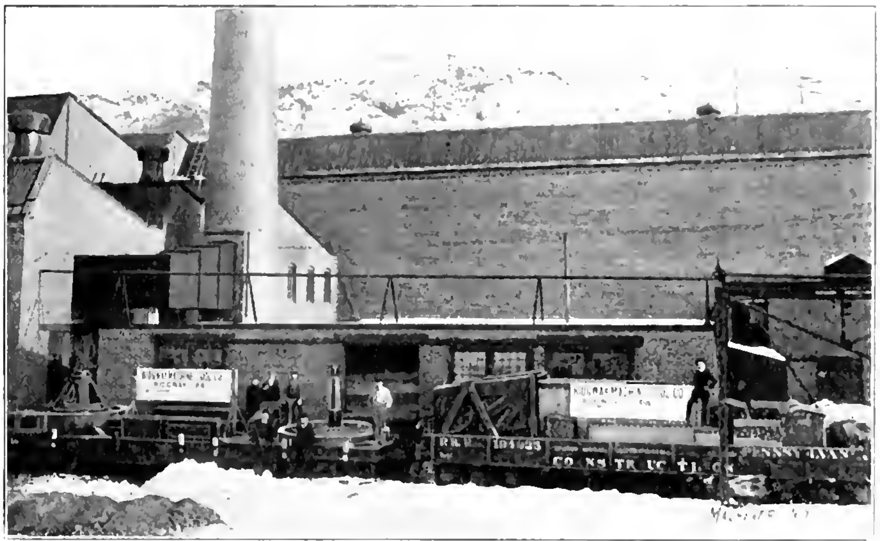


Fig. 1. An Important Event the first Shipment, consisting of the 10-16 foot Extension Boring Mill described in this article

The plant of the Ridgway Machine Tool Co. is eq[illegible] manufacture of the heaviest and largest sizes of ma[illegible] and is large enough to accommodate several times th[illegible] of employes now at work. It is one of the few ma[illegible] plants in the country equipped with its own found[illegible] buildings are of steel construction, with saw-tooth roof, and the structures for the different departments are of different heigh[illegible] to accommodate the class of work to be done. The crane and track service provided for handling the work in all the departments, and transferring it from one department to another is more complete, even, than is usually found in modern shops where a great deal of attention is always paid to these features. The arrangement of the several buildings is such as to insure progressive movement of the product through the several steps of manufacture, from the pattern shop and stock room to the point of shipment. Provision is made for enlarging any or all of the departments without destroying the continuity of arrangement, and if, for example, the whole plant should have to be doubled in size the same systematic plan for the movement of the work could still be maintained.

In Fig. 6, on the next page, is a plan of the works. Starting at the left are the pattern shop and pattern storage building, where also are located the offices. Next comes the wash room, fitted with expanded metal lockers for the employees and it is here that the men employed in the different departments enter and leave the plant. Following this comes the stock room where bar stock, bolts and similar stock are kept; and on the other side in the same end of the building, is the forge shop.

The several departments mentioned are all included in a one-story building with roof made high enough to accommodate the work done in the forge and pattern shops, and to give good air and ventilation; but not as high as in the machine shop and foundry where head room for traveling cranes is required. This building is not of saw-tooth roof construction but is lighted by side windows.

The foundry follows next and is offset to one side of the pattern and forge building, so that it can be extended to the left, alongside of the latter, to allow future growth. The foundry adjoins the machine shop and is of the same height as the erecting department of the machine shop. Both the foundry and erecting shop have head room enough for swinging th[illegible]

Fig. 2. General View of the Plant of the Ridgway Machine Tool Company

Fig. 3. View of Works, showing Saw-tooth Roof Construction

In Fig. 3 the Machine Shop is at the right of line A-B, the high portion being the Erecting Shop and C C C, etc. the bays for machine tools. The Foundry is at D and F

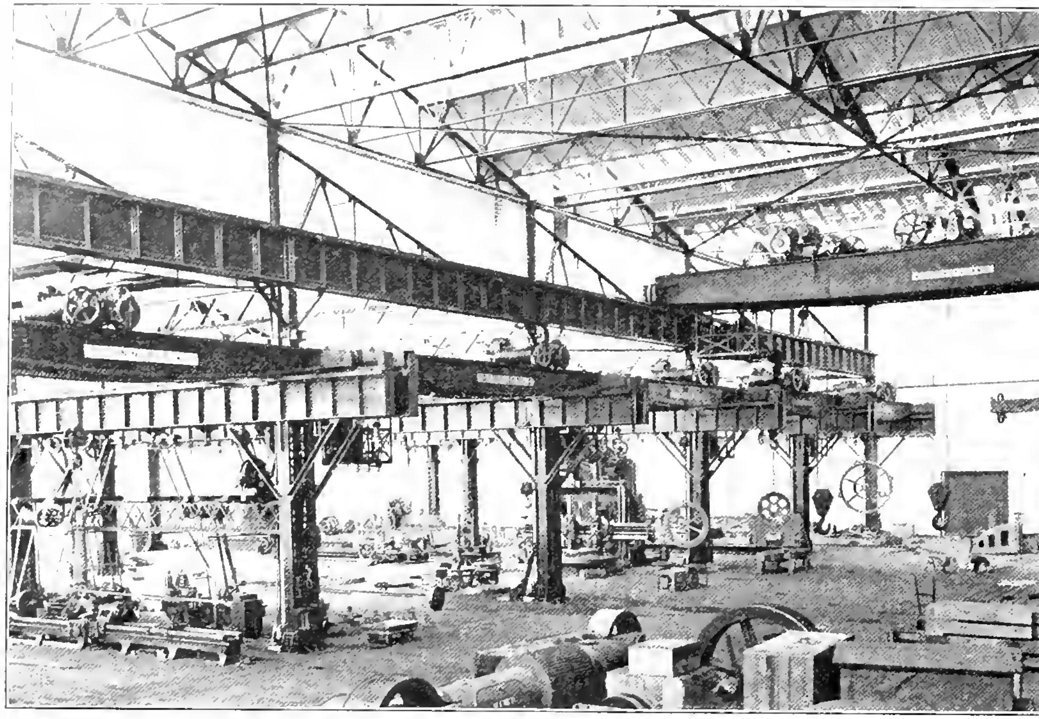


Fig. 4. Showing five Bays for the Machine Tools. Crane Tracks extend a short distance into the area of the Erecting Floor.

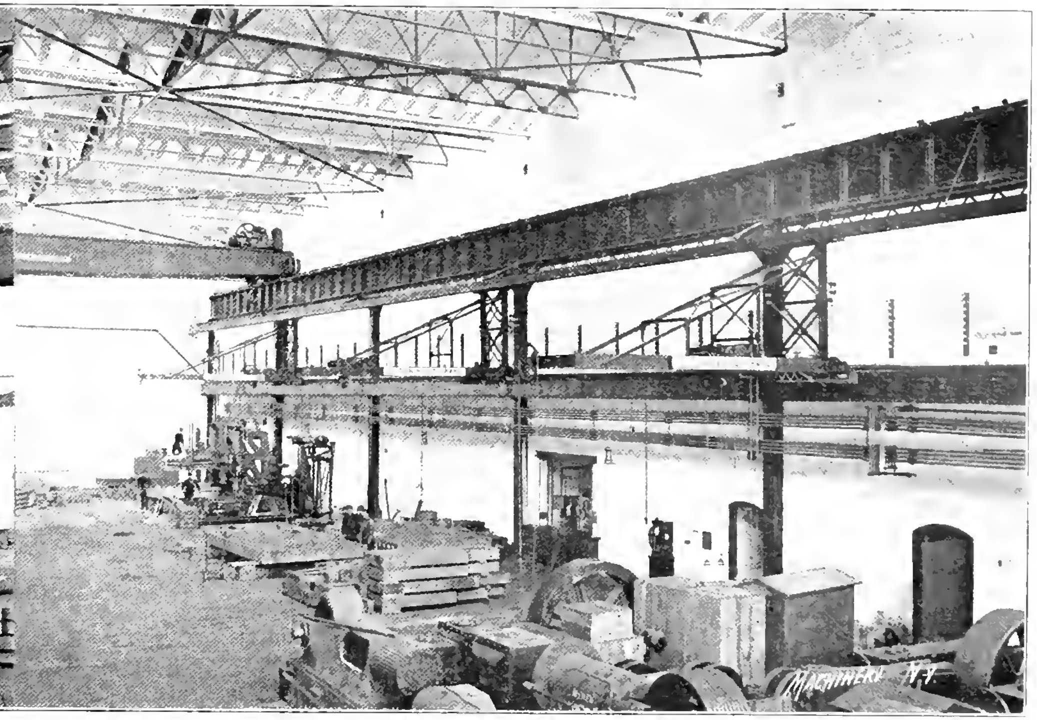


Fig. 5. Erecting Floor, served by a forty-ton Traveling Crane and three two-ton Cantilever Cranes

General Views of Machine Shop

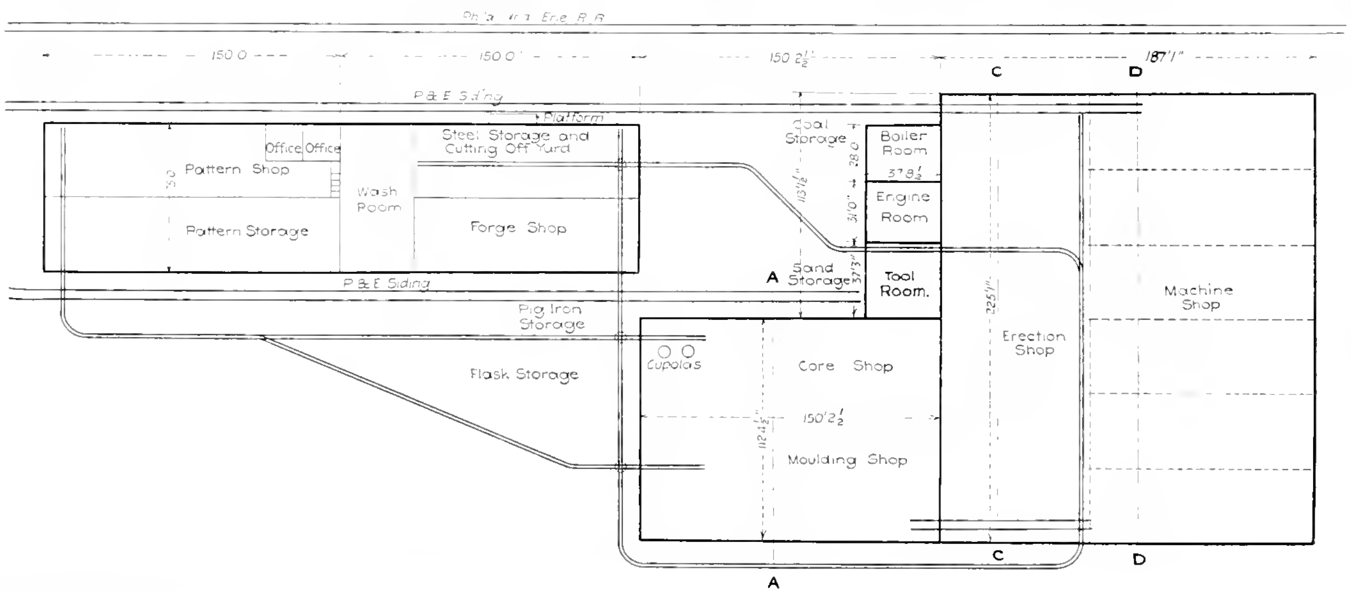


Fig. 6. Plan of Works.

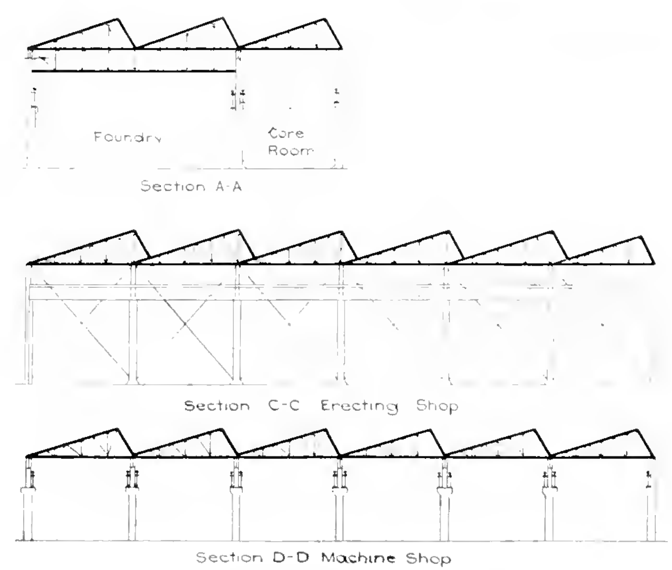


Fig. 7. Cross-sections of Buildings.

heaviest castings over any large work that may be on the floor, by means of the cranes which serve them. Still further to the right in Fig. 6, and at the extreme end of the plant, is located the machine shop proper, where the machine work is done. This part of the shop is built in the form of six bays, extending at right angles to the erecting shop. Each bay is served by a traveling crane and is lighted from the roof.

In Fig. 7, at the right of the plan view, are cross-sections taken on the lines *AA*, *CC* and *DD* of the plan, showing the relative proportions of the roofs, the heights of the crane runways, etc.

The half-tone view, Fig. 3, on the first page, is lettered to assist in further explanation of the scheme of construction. This view is taken from a position near the lower right-hand corner of the plant, in Fig. 6. It shows the blank walls on the two visible sides of the building, designed to be removed in case of further extensions. That part of the works to the right of the line *A B* is the machine shop, the high portion being the erecting shop, and *C*, *C*, *C*, etc., the bays for the heavy and light machine tools. The foundry is located under the sections *D* and *E* of the roof, and the pattern shop and blacksmith shop are still further to the left.

In equipping and organizing the plant, as much attention has been paid to the convenience and health of the employes as to any other features more directly associated with the output of the plant, as ordinarily considered. First of all, the water, taken from driven wells, is pure and is distributed throughout the works where it is supplied in sanitary porcelain drinking fountains. The fountains consist of small basins having a jet at the center which bubbles upward a distance of two or three inches, and the water may be taken into the mouth from this jet without the use of drinking cups. These fountains are exceedingly neat and are not only a convenience, but a marked improvement over the usual arrangement to be found in most manufacturing establishments.

Another convenience is the lunch room wh[illegible] located over the tool room, and where there are tables and [illegible] and a gas stove is provided for the employes' use during [illegible] lunch hour. One of the regulations of the company is that no lunches shall be eaten in the shop proper, but that this room shall be used for that purpose.

Features of the Machine Shop.

In Figs. 4 and 5 are two general machine shop views, taken from nearly the same point of the erecting floor. The erecting shop is served by a 40-ton traveling crane with two trolleys and crane hooks for convenience in loading the tools for shipment. The car tracks run across one end of the erecting shop at right angles to the crane tracks, instead of parallel to the crane tracks, as is usually the case. In loading a lathe bed, for example, it would be set parallel to the car and then picked up by the two crane hooks and deposited on the car. It is the purpose to do much of the erecting on the right-hand side of the erecting shop (referring to Fig. 5) and for convenience in assembling the machines there are three 2-ton cantilever cranes on this side of the shop supported by wheels running on tracks which extend from end to end of the shop. A large bedplate 18 by 20 feet has recently been set in this shop, to be used in drilling, boring and milling some of the heavier work, by means of radial drills designed so that the vertical column of the drill can be bolted directly to the bedplate in any convenient position. These bedplates appear in Fig. 5, and beyond is the [illegible]-foot boring mill already referred to, completed and ready for shipment. This mill was erected over a pit which has been sunk at one end of the erecting floor, for convenience in assembling parts which are located in the base of machines, an arrangement especially convenient in erecting boring mills and planers.

In the manufacturing part of the machine shop there are four bays fitted with 10-ton cranes, where the medium and small work is done, and two with 30-ton cranes for handling

Fig. 8. Drafting Room. Mr. F. B. Cockburn, Head Draftsman, is seated at the Desk

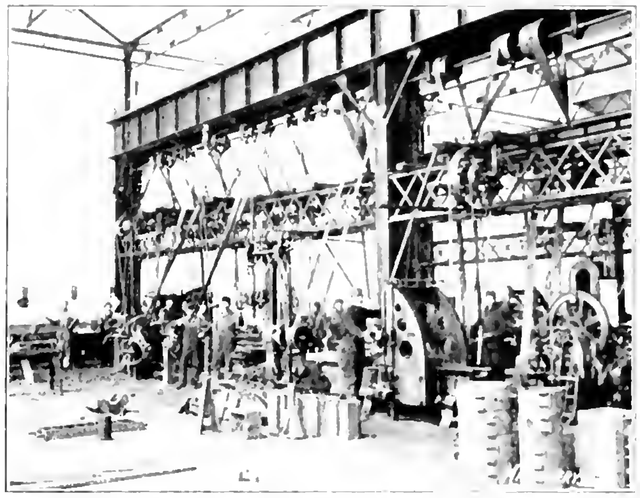


Fig. 9. Bay where Small Tools are Located. Latticed Girders used to support Countershafts

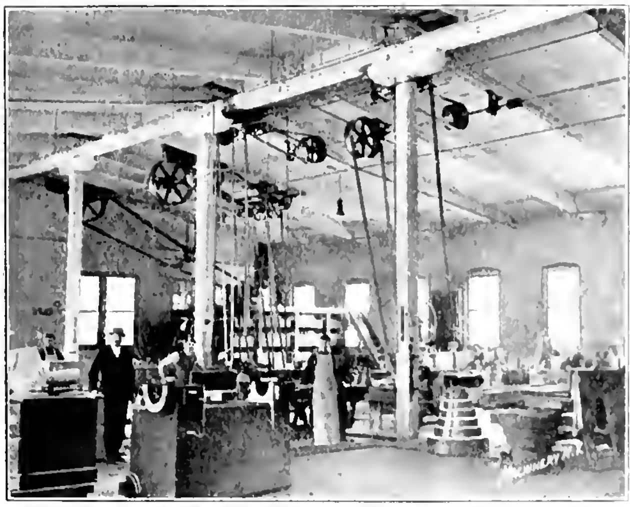


Fig. 10. Corner of Pattern Shop

Fig. 11. Blacksmith Shop

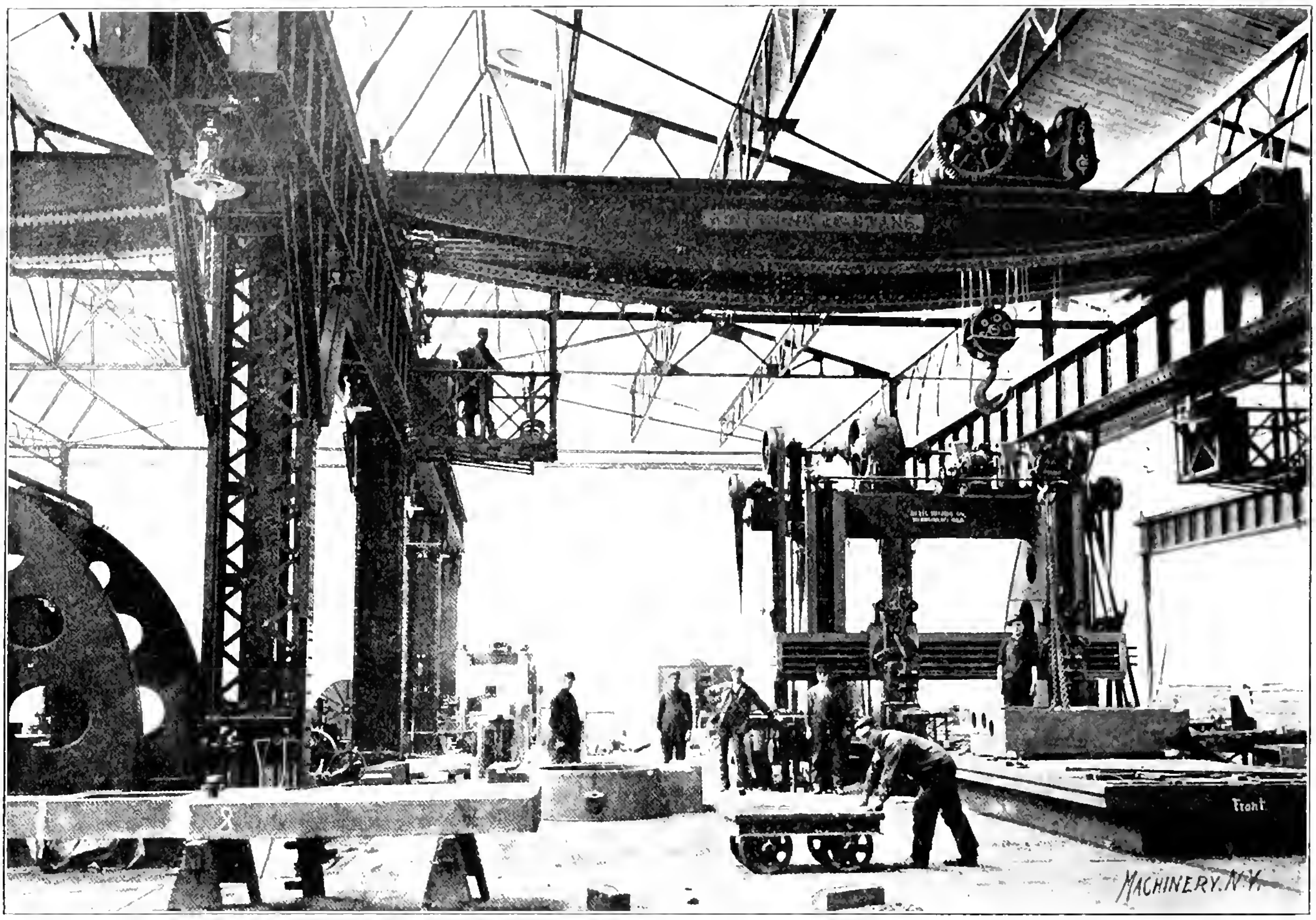


Fig 12. One of the Machine Shop Bays where the Heavy Tools are Located

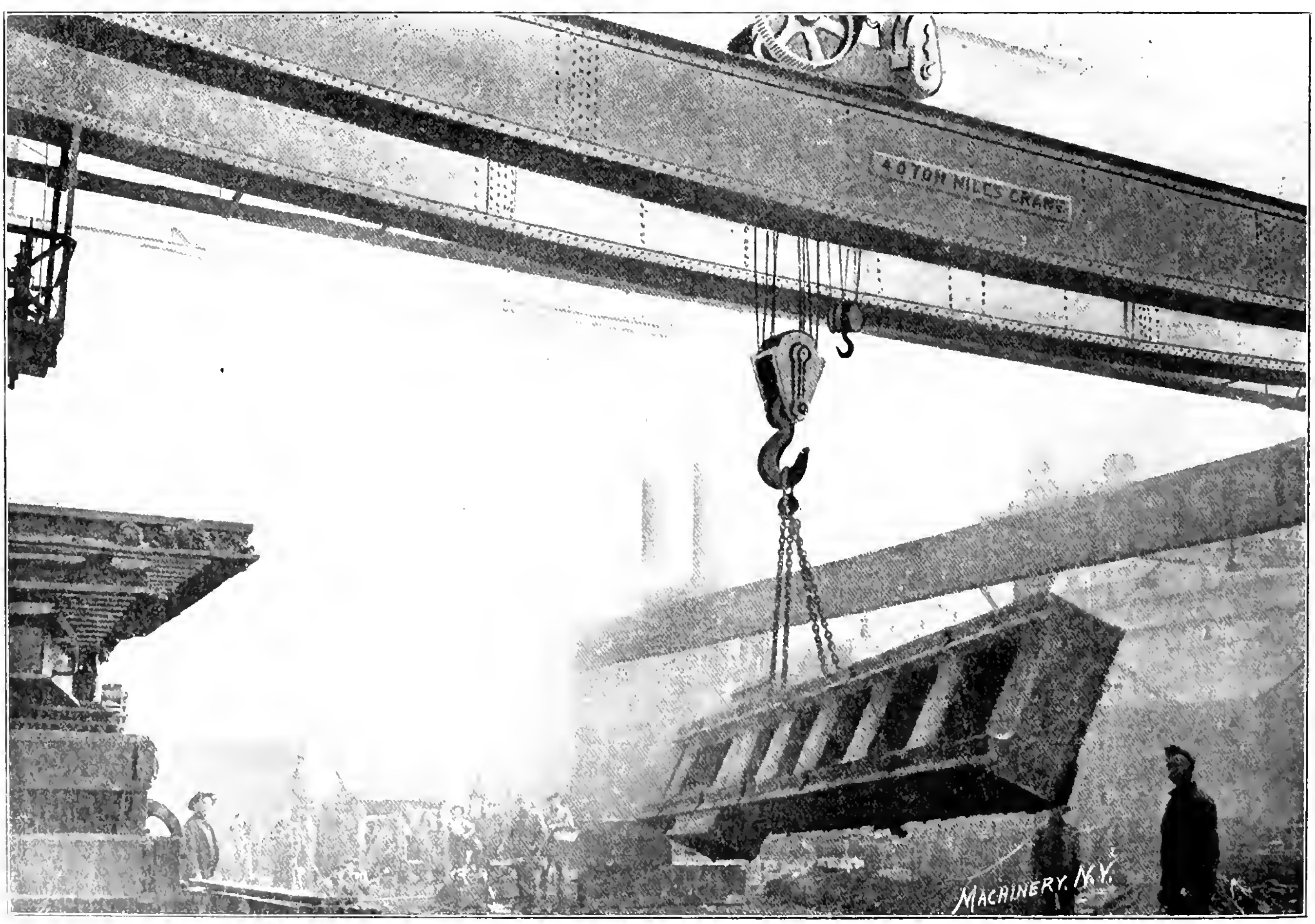


Fig 13 Main Floor of Foundry, served by two Cranes of seventy-five foot Span.

the large castings to be machined by the heavy machine tools in this section. The tracks on which these several cranes run extend a few feet into the area of the erecting shop, to enable castings to be transferred from the machine working department to the erecting department.

Foundry and Blacksmith Shop.

The foundry is complete in its appointments and equipment for the turning out of a large quantity of heavy work. The main floor is served by one 40-ton and one 25-ton crane having the unusual span of 75 feet. The other section of the foundry is known as the core shop, where the cores are made and the small molding is done. The foundry is supplied with natural gas, compressed air, and with water from the service pipes of the plant. At every column in the foundry connections may be made for gas, water or compressed air, all of which are thus at the service of the workmen at any time and in any part of the foundry. The compressed air is used extensively, the foundry elevators even being operated by air pressure. Molding machines are employed for small work. Sand mixers, consisting of foundry riddles, given a reciprocating motion by small pneumatic pistons, have been found very serviceable both in sifting the sand and in mixing it. The core ovens are heated by natural gas, and gas is used more or less throughout the foundry for drying and hardening the surfaces of molds.

The blacksmith shop has down-draft forges, and the power hammer, like the elevators in the foundry, is operated by compressed air instead of steam. This feature is much appreciated because it avoids trouble from water of condensation, always present where steam is used, and a source of annoyance owing to its trickling down the piston rod and over the hammer head. Like the other parts of the plant, the blacksmith shop and the foundry are well lighted and clean.

Distribution of Power, Heat, etc.

The engine room and boiler plant are models in their arrangement and equipment. A 150-kilowatt generator, direct-connected to a tandem compound McEwen engine—both supplied by the Ridgway Dynamo & Engine Co.—furnish the power for the single-voltage system of 240 volts used throughout the plant. The works are wired in three separate circuits, one for the cranes, one for lighting and one for the shop motors. The circuits are also separate for each department and all the circuits are controlled at the switchboard in the engine room.

Water used at the works is obtained from driven wells, and in order to bring the pumps sufficiently near water level to raise the water it was necessary to place the pumps in a pit below the level of the engine room floor. There are two boiler feed pumps, a service pump, and a fire pump, the latter of 750 gallons per minute capacity. The service pump and fire pump are controlled by Mason regulator valves, and automatically maintain water pressure in the mains. The pumps are all piped so that any one of them may be shut off without interfering with the steam connections to the others—a problem that is not altogether easy to work out without complicating the piping.

The entire plant is heated by exhaust steam, and after mature consideration it was decided to use steam coils along the walls and under the roofs of the several buildings, as might be most convenient, instead of the forced hot-air system. The coils in the different departments are connected to main distributing pipes leading from the exhaust pipe of the engine and are so located that they drain away from the points where the steam is supplied to the coils. The drain pipes are all connected with the sewer, and although a very large number of square feet of heating surface are required for heating the works, and a great many separate coils are employed, no difficulty has been experienced in maintaining a flow of steam through all the coils. The plant has been heated in a satisfactory manner throughout the unusually cold weather of the present winter.

The First Boring Mill.

On the next page are two views of the boring mill just completed by the Ridgway Company, as it appeared set up in the shop. The most characteristic feature of the machine is the design of the housings which are made wide at the top instead of being of parabolic form, after the usual design. This construction enables a wide tie piece to be bolted between the uprights at the top and this, together with th[illegible]e at the back, makes what is virtually a substantial b[illegible]ng, closed on all sides but one, and that one stiffened [illegible]oss rail itself. When the cross rail is at the upper end [illegible] housings and the tool is taking a heavy cut, the thrust of the tool is resisted to a greater extent by both housings together (owing to the wide brace at the top) than would be the case if there were only a narrow brace at the top. By this means the most rigid possible construction is probably attained. The specifications for this mill call for two cuts, ½ inch deep to be taken simultaneously on high tensile steel at a cutting speed of 40 feet per minute and 1-16-inch feed, on a circumference of 10 feet in diameter. After the mill was set up at the Bucyrus shops Superintendent Morgan visited the plant to demonstrate the capacity of the machine and brought home with him a collection of steel turnings that were so unusual as to excite the admiration of those who have seen them. They would probably satisfy the most ardent high-speed steel enthusiast. The mill was tested on high-tensile steel up to a point where the cut was from ½ to 1 inch deep, the metal turned being somewhat irregular, the feed was 3-16 inch and the cutting speed 50 feet per minute. This was accomplished at a circumference of 10 feet diameter, and 60 horse power was required, or twice the rated capacity of the motor, which, however, stood up to the work. The test broke the high-speed tool, and appeared to be the limit beyond which the tool could not go, showing that the mill was beyond the capacity of the high-speed steels.

To secure a strong drive for the table, the steel driving pinion meshes with teeth cut in a large steel ring about 8 feet in diameter placed under and attached to the table. The feed is by means of a friction drive shown in the side view of the mill, consisting of a friction wheel running in contact with a friction disk. The usual order of arrangement is reversed, however, because in this case the wheel drives the disk. To maintain sufficient pressure of contact, the disk and its supporting shaft are placed over the wheel and are kept in contact with it in virtue of their own weight. The wheel is made up of compressed leather disks bolted between the flanges, and in an annular recess in the face of the disk is secured a leather ring forming the friction surface against which the wheel runs. With these two leather surfaces in contact an abundance of power can be transmitted and the feed is easily adjusted by moving the friction wheels in or out from the center of the disk. This machine is driven by a 30-horsepower motor made by the Ridgway Dynamo & Engine Co.

This motor is designed with a 4 to 1 range having ten speeds by means of mechanical changes. Thirty table speeds are obtained in correct geometrical ratio, ranging from 25 feet per minute on a diameter of 6 inches to 16 feet per minute on a diameter of 16 feet. All changes are made by means of levers near the front of the mill within easy reach of the operator. Certain important dimensions are as follows: The table is 10 feet diameter, 10 inches deep at the edge, supported on a circular track of large diameter, which is so constructed that the bearing surface is immersed in oil. The spindle is carried in two bearings wide apart, to insure stability. The cross rail is 31 inches deep, and is held to the uprights by means of clamps on the inside edges so that the strain is not transmitted through the weakest part of the cross rail. There are also additional clamps on the outside edges of the uprights. The heads have a 34-inch bearing on the cross rail and the guiding surfaces are both on the lower edge of the cross rail, thus greatly diminishing the cramping action due to heavy cuts when the tool bars are extended below the cross rail. The tool bar is of large cross section and has a 4-foot travel. Each bar is separately counterweighted. The complete weight of the machine is 106,000 pounds.

It is the purpose of the Ridgway Machine Tool Co. to use the Thompson-Ryan variable-speed motors, built by the Ridgway Dynamo & Engine Co. as a feature of their machines, and in some cases the design of the machine will be made dependent upon the use of this motor as, for example, in their radial drills. A description of the Thompson-Ryan variable-speed motor and the system of control appears in this number as one of the series of articles upon variable-speed motors by Mr. Baxter, now running. In this motor a speed variation

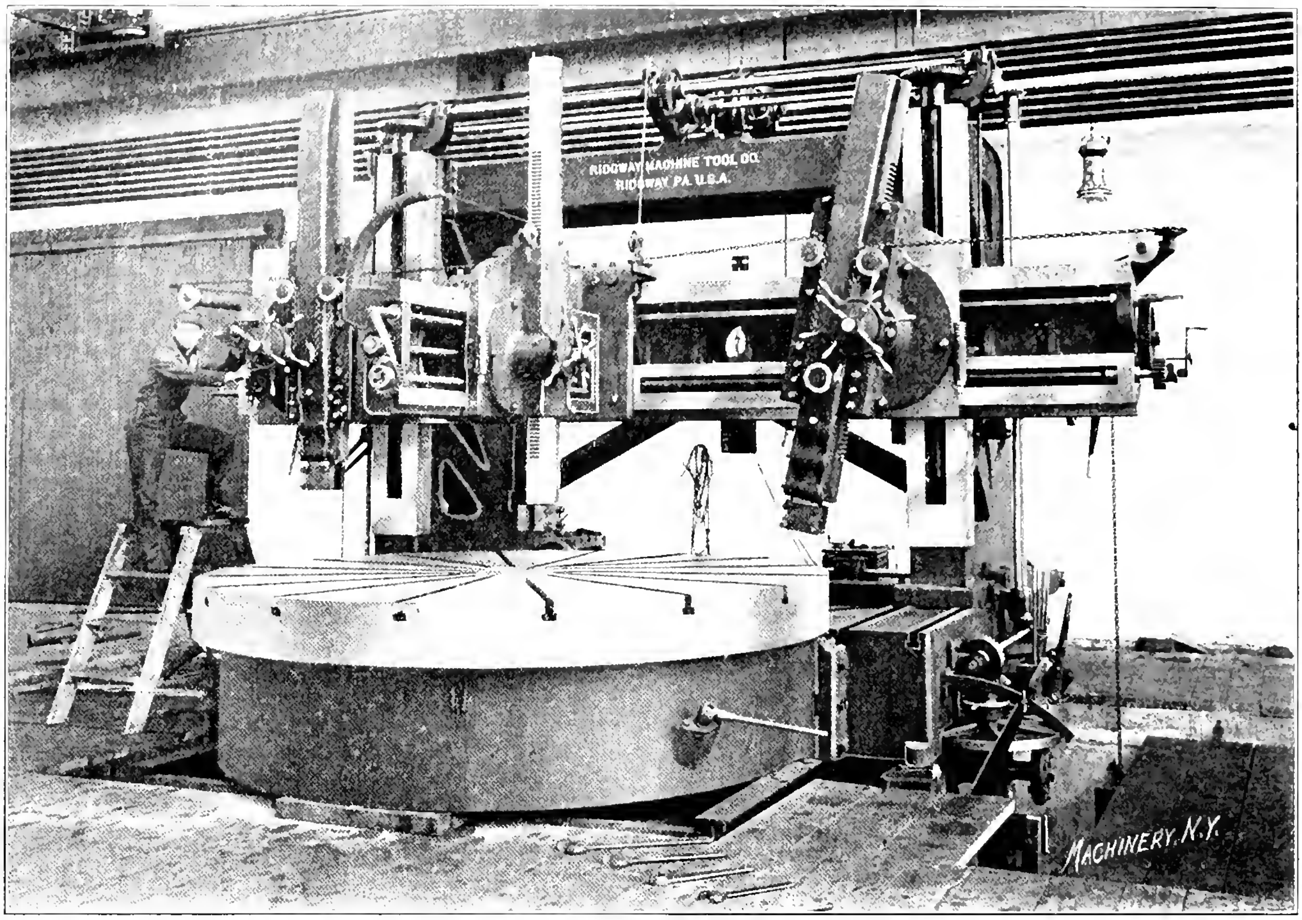


Fig. 14 Ten-sixteen foot Extension Boring Mill, Built for and Installed at the Bucyrus Company, South Milwaukee, weight, 106,000 pounds

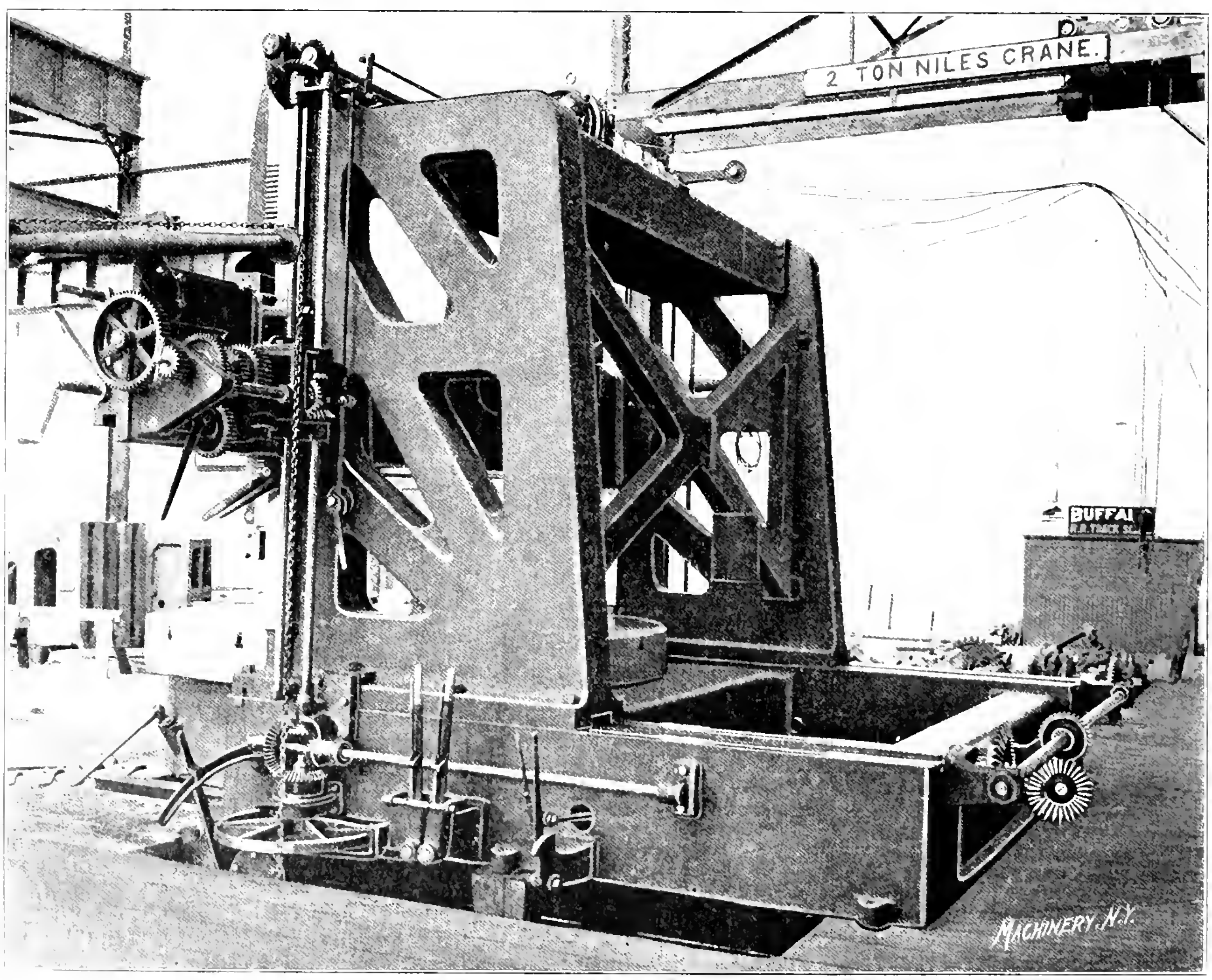


Fig. 15 Rear View of ten-sixteen Extension Boring Mill, showing Rigid Construction of Uprights.

as great as 6 to 1, or even more under certain circumstances, is obtained with a single-voltage two-wire system without the sparking of the brushes, by means of so-called balancing rings carrying magnetizing coils placed between the field and armature. The magnetizing action of the coils is directly opposed to that of the armature and neutralizes the distortion of the field that occurs when a wide variation in the speed is attempted on the single-voltage system. All the cranes in the works are driven by these motors, having a speed variation of 4 to 1. The larger tools are also equipped with them, and the smaller tools are driven in groups through countershafts. One unusually interesting application of the motor is the driving of a 48-inch Pond planer by attaching the motor direct to the driving shaft in place of the belt pulleys. The motor reverses with each reversal of the planer and gives a range of table speeds from 20 to 60 feet per minute. A small pilot controller, operated by the usual dogs on the planer table, controls the main controller, and the reversal is said to be so accurate that not only does the table stop at a line, but the armature of the motor itself stops at a line. The reversal is gradual and the drive is giving good satisfaction in spite of the fact that the momentum of the rotating parts of the motor represents a large quantity of stored energy to be overcome. The details of this drive are not yet available for publication, but the motor is said to work alternately as motor and generator at the points of reversal, feeding current into the line when the armature is being brought to rest.

* * *

ELLIPTICAL CHUCK.

JOHN D. ADAMS.

The accompanying cuts, Figs. 1 to 7, show the construction of an elliptical chuck designed for milling elliptical holes with an ordinary lathe. The face of the chuck is a cast-iron plate 20 inches diameter, which, instead of traveling in a circle, moves in an elliptical orbit carrying with it the work to be drilled. The cutting is done by a small end mill mounted in the toolpost and driven by a belt from the countershaft overhead. Since the axis of the end mill remains stationary in reference to the center line of the lathe, but the work travels in an ellipse, it is evident that an elliptical groove will be formed, leaving a core which will drop out when the hole is completed.

Fig. 1 shows a front elevation and a horizontal cross section through the center of the spindle. Fig. 2 shows a cast-iron plate, *B*, which is threaded to fit the lathe spindle. The front side of this plate has a dovetail groove, one side of which is made adjustable for wear by means of the piece, *G*, shown in Fig. 7. The face of the chuck, *C*, shown in Fig. 3, is a cast iron plate, planed smooth on the face and [illegible] on the back to match plate *B*. The two blocks on [illegible] plate *C* pass (with considerable clearance) through [illegible] ings in the plate, *B*, as shown in Fig. 1. On these [illegible] are fastened by capscrews the two steel blocks, *E*, [illegible] Fig. 5. These two blocks travel around the cast-iron [illegible] shown in Fig. 4, as indicated on the sectional view in F[illegible]. The projecting lugs on this ring fit into the horizontal groove in the piece shown in Fig. 6. Fig. 6 is the only piece that is permanently attached to the lathe. The opening in the center is slid over the lathe spindle, and after being carefully lined up it is screwed to the headstock of the lathe. It is necessary that the horizontal groove be lined up parallel with the base of the lathe and at right angles with the center line of the spindle.

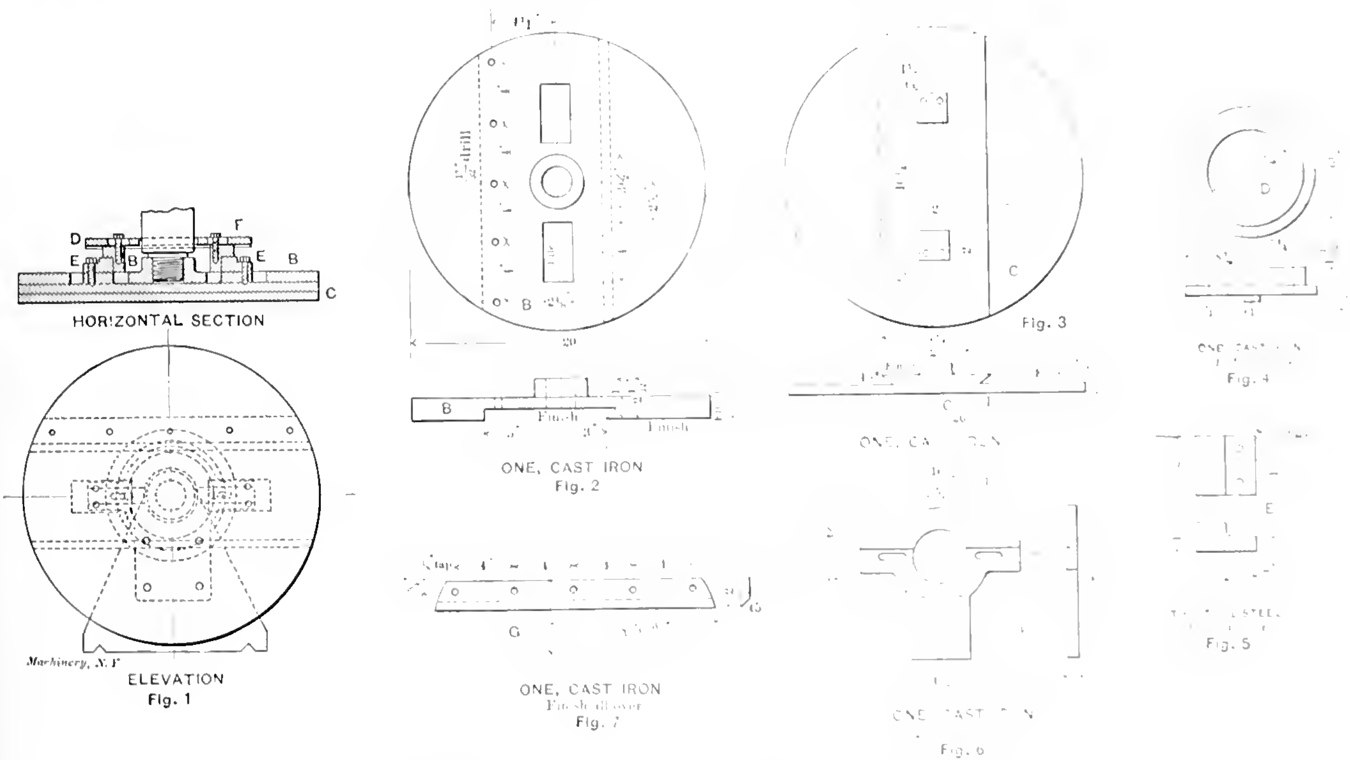
In placing the chuck on the lathe the piece in Fig. 6 with the ring in Fig. 4 attached, should be in position first; then plate *C* is carefully adjusted to plate *B*, which is then screwed on the spindle. Lastly, the steel blocks in Fig. 5 should be fitted close to the stationary ring so that they will travel around it without backlash. It is evident that when the ring in Fig. 4 is drawn away from the center, either forward or backward, the revolving steel blocks will cause the plate to travel in an elliptical path, the eccentricity of which will depend upon the distance this ring is set off center. The size of the ellipse is regulated by the cross feed or the distance the end mill is off the axis of the lathe.

* * *

SOMETHING ABOUT ALUMINUM.

EARL N. PERCY.

Engineers often ask: "What is the real value of aluminum? It is a pretty and interesting metal, but what practical uses can it be put to, and what does it cost?" This professional dubiousness is quite pardonable, as the most useful characteristics of aluminum are not entirely its lightness, nor does its lack of strength militate against it to any great extent.



Elliptical Chuck for Milling Elliptical Holes with an Ordinary Lathe

It can be purchased in blocks, ingots, pigs, bars of [illegible] section, sheets, wire, and in various manufactured forms. The prices in ingots quoted to date are: 99 per cent pure [illegible] cents a pound; and 90 per cent pure 34 cents a pound, the finished product varies according to the finish.

The metal can be readily welded by electricity; but soldering is an unsatisfactory process, since the greater conductivity of the metal removes the heat from the solder. The best aluminum solder is 80 per cent tin and 20 per cent zinc. This should be fluxed with a composition of 80 per cent stearic acid, 10 per cent tin chloride and 10 per cent zinc chloride.

A pure nickel soldering bit should be used, as copper discolors aluminum. This can be worked successfully if the aluminum be heated first, or kept hot with a blowpipe.*

Aluminum is 2.6 times as heavy as water, consequently will not float. It is 1-3 the weight of iron, and copper is 3½ times as heavy. It is 3 times the weight of good oak wood. It does not rust or corrode, except with strong alkalies or acids. Gold and silver, only, exceed it in malleability, it having been drawn down to a thickness of 0.0005 inch, and is most malleable between 400 and 600 degrees F. It has been made into tubes by the Mannesmann spiral process.

Aluminum stands next to copper in electrical conductivity. Taking silver as 100, aluminum ranks variously from 55 to 64. As gases are easily absorbed, aluminum should not be heated much beyond its melting point, 1,300 degrees F., and the shrinkage will be about 17-64 inch per foot. It, of course, will have to be melted in plumbago crucibles. As there are no aluminum oxides readily formed, the scums or oxidations will consist entirely of impurities, and will do more good than harm. It can be cast in dry or green sand, and the castings are about as strong as cast iron, running from 13,000 to 17,000 pounds tensile strength. Sheet and bar aluminum run about 26,000 pounds, and wire about 45,000 pounds. The wire has a specific gravity of 2.68, and an ounce of it can be drawn out 11,400 yards, to weight of only 0.042 grains per yard.

Pure aluminum is too soft and weak for most purposes, but it unites with all metals except mercury and lead, though with difficulty with antimony, and its alloys are very useful. Mixed with from 2 to 8 per cent of nickel it makes a valuable, hard alloy of tensile strength of some 50,000 pounds. Nickel-aluminum alloys have as much spring as the hardest of hard-drawn brass. Aluminum bronze, containing 5 to 11 per cent of aluminum, is a strong, fine-grained bronze, suitable for fine instruments. Copper-hardened aluminum has the strength of a soft bronze but the lightness of aluminum, and contains 2 to 15 per cent of copper. Aluminum steel is, next to nickel steel, the strongest steel made. Aluminum makes cast steel flow better and drives out occluded gases, making the metal more homogeneous.

Among the commercial uses of aluminum, none is more important than its application to automobiles, the bodies of which are made of laminated sheet aluminum, as are also the hoods and radiators. Many castings, formerly made of cast iron, are now made of aluminum alloys, while bronze parts wear just as well if made of aluminum bronzes. Crank cases, covers, glands, cylinder heads, etc., are made of aluminum bronzes or delta metals. Another very popular use is for open-air signs, because the metal never tarnishes or stains, and it makes pretty and artistic signs, the ductility of the metal making it possible to beat out beautiful and complicated designs. Aluminum dishes never stain or tarnish, and food cannot burn in them, because there is no rough surface or scale for it to stick to. For the same reasons, and also because of its great electrical conductivity, it is adapted to the construction of fine instruments, scales, electrical apparatus, and name plates. In connection with the latter, an imitation Cremona violin was recently exposed because of the aluminum name plate, which it would have been impossible for Stradivarius, or any other man in the seventeenth century, to have procured. Lamp shades, trimmings, clasps, visiting-card cases, and many other ornamental objects are now made of aluminum, for in spite of its cheapness, it has lent itself very well to the arts as well as being of great use in the engineering world.

* * *

MORE SHOP COST TROUBLES.

IAYONAC.

"I was right down tired of seeing the boys plodding along in the same old prehistoric way of doing things with never a possibility of improvement, and I had often kicked pretty badly when the superintendent got at me on figures." "See here," he would say, "here is an office cost of that pump job you did about three weeks ago. In my opinion that job cost about 70 per cent more than it should have done. I cannot understand just what you fellows are doing with your time up there, and let me tell you right here it has got to stop. The office has the laugh on you, and whenever they estimate on a job, you are bound to exceed it, hands down. What is the matter anyhow? Aren't your men all they should be, or don't you know just how the jobs should be done? I'm dead tired of all of you, and your ways of getting through work." The superintendent was referring to the brass-finishing department of which I was foreman. During all this talk I was getting pretty hot, and when he finished, and gazed into my face for the first time, the thermometer showed boiling point. "Now you are through," I gasped, "allow me to tell you that your scrap heap is just what you have made it. You know my opinion on that subject by heart, but you won't let me alter the state of affairs one durned little bit. And why? Just because it means sinking a few dollars to buy tools to bring the thing up to date. I tell you, the Boss hates machinery like snakes, just because it costs money to drive. You'd much rather see a fellow wearing himself out hacking down trees with a dull axe, or digging his grave with a hay fork, because you don't think he can earn his money unless he just wipes the sweat off his face all day long. May be you don't think I know you're way back in your methods, and perhaps you don't think I know that the jobs are costing piles more dollars than they ought to. For your edification let me tell you, sir, that you are fossilized and every man jack, from the boiler tender up, knows it, too. Send down your estimator, and I'll teach him his business—on shop costs, at any rate."

It was the superintendent's time to get hot, for he was not used to such plain talk. I had previously explained to him in a mild kind of way that we were woefully deficient in the matter of shop tools and that what we had needed patching up badly; that it could not be expected that we could turn out high-speed work on slow-speed machines that were furnished with broken gear and shaky slide rests; that where we used a file, other concerns employed a grinder; that the use of emery wheels would knock a big percentage off the cost of the work. "Now I want a three-spindle sensitive drill," I continued, "and I have here an estimate which will prove to you that I can save you the cost of this drill on one job alone. I want to quit chucking small jobs on the lathe faceplate. I want a sensitive drill mounted on a standard with just a simple lever feed motion, and, as we are now on the subject, I will be glad if you will make up your mind right here whether I get it or not." I placed the figures before him and we talked them over. "It seemed all right," he said, "and believed that amount of money could be saved." "Now I'll take you to the Boss and give you some idea of what it is like to get money in that direction."

The Boss was a gentleman who never appeared in the works, but managed the business from his office. His desk was furnished with a series of push buttons, each of which communicated electrically with the superintendent's and various other offices. He scorned the use of the 'phone, and the individual summoned had to appear before him in person. He hated machinery because it cost money, and because its intricacies were unfathomable to him. Also, he could never understand why a machine purchased fifty years ago should be obsolete to-day. The Boss was busy when we arrived. He was "fixed up" with the traveling man of a church window concern, and they were figuring up the cost of a stained glass window, to be put in the local church in memory of his wife, who was lately deceased. That over we were ushered in, and the subject of our interview was entered into without further delay. The matter of cost and the saving was explained to him, together with the alternative processes at present in vogue. Then the spirit of meanness entered into him. He made some calculations and inquired why a two-spindle drill would not do as well, and besides he did not altogether see the use of having a standard. "Why not cut that out, for that would cost more money, and put the drill on a bench?" I explained that the three spindles were a necessity as with two spindles the work would have to be handled twice, instead of once, and that meant both time and money. Anyhow, he

* All known aluminum solders disintegrate by electrolytic action, the rapidity of the process depending on the conditions. Immersed in water, soldered aluminum pieces come apart in a few days.—EDITOR.

did not see why a one-spindle drill should not satisfy me, and with that remark, placed the whole of the papers into a drawer, where, I afterward learned, he sidetracked all other schemes for improvements. He "guessed the matter would have to lay over until such time as he could give his attention to the scheme, for it required some consideration." "In the meantime, my boy," he said, addressing me, "remember this, that God gave smart young men like you brains to devise means of producing work without the aid of tools or machinery." This struck me all of a heap and I backed out to explode outside. I told the superintendent I was right down sorry for him, but I hadn't a wife and family, and didn't have to stand the racket, and I reckoned I'd rather go out and cut grass with scissors than hang on to my job any longer than it took him to find another fool to fill it.

Some time after I quitted I heard that the Boss turned down the superintendent because he was leaning too much toward the boys. That drill scheme still remained in the drawer, and they went ahead with the job on the old lines, and had the usual racket on the cost. When the Boss says a thing the new man always answers, "Yes," and has his own thoughts on the matter.

* * *

A NOVEL PROCESS FOR TESTING LUBRICANTS.

DR. ALFRED GRADENWITZ.

On account of the noxious influence exerted by lubricating oil of a too liquid condition, the importance of having a means of controlling the consistency of the oil is self-evident, the more so as the viscidity of most oils will decrease rapidly and to a high extent for increasing temperatures. Besides the degrees of viscidity, the internal friction varies somewhat for different oils, being also influenced by temperature as well as by the difference in speed of the sliding surfaces. A small increase of the friction resistance on every one of the sliding surfaces may, in the case of extensive power transmission plants, including a large number of machines of low energy absorption, have a paramount importance for the total consumption of power and accordingly for the economic condition of the whole operation. Any oil used in such plants should, therefore, be carefully examined in this respect.

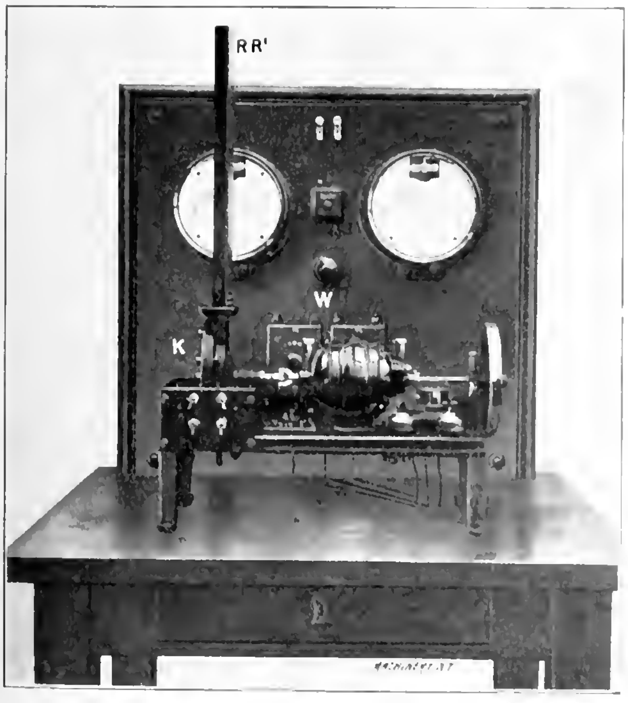


Fig. 1. Electric Heating and Speed Measuring Device.

In a new process patented by the Allgemeine Elektrizitäts Ges. Berlin, the amount of displacement of a liquid column at rest is used as a measure for the internal friction resistance of lubricating oil, other particles of the oil to be examined moving along at the foot of the column practically in the direction of the latter. The higher the friction resistance of the oil to be investigated, the higher will be the effect on the liquid column, so that the displacement obtaining for equal speeds will afford a simple method of measuring, susceptible of a ready comparison, for the internal friction resistance of different oils. In Fig. 2, *K* represents a closed compartment filled with the lubricating oil to be examined, and containing the flywheel, *F*, whose driving axle traverses the wall of the compartment. To compartment *K* are connected two vertical tubes, *R R'*, filled with the lubricating oil up to about half their height, thus forming with compartment *K* a system of communicating tubes. As soon as the flywheel is set rotating, the lubricating oil in the compartment surrounding the flywheel is compelled to take a part in the movement, there being on the path traversed by the circumference of the flywheel a friction of the moving liquid particles against those filling the foot portions of the tubes, *R R'*. The friction

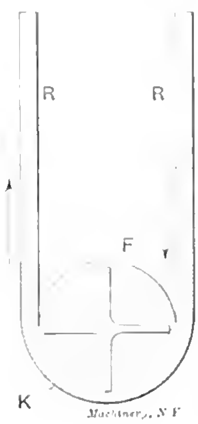


Fig. 2

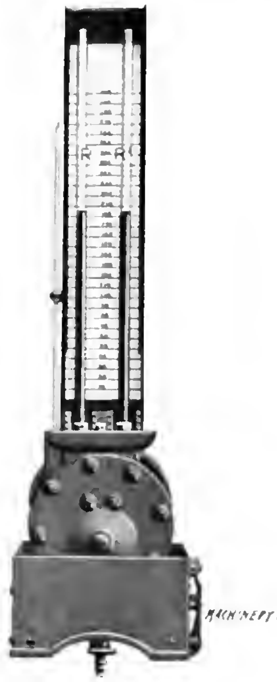


Fig. 3

resistance results in the liquid column rising in one and falling in the other vertical tube. The level difference of the two liquid columns will accordingly, considering both its specific weight and the temperature of the liquid, afford a means of ascertaining the internal friction resistance of the lubricating oil.

In order to enable the lubricating oil to be examined at different temperatures, an electric heating device for heating the oil compartment, *K*, has been provided, while the controller, *W*, permits the number of turns of the driving motor to be varied within wide limits. The outfit further comprises a speed-measuring device, thrown in and out by means of electricity, as well as a voltmeter and an amperemeter, Figs. 1 and 3, the whole being mounted on a small table with switchboards.

* * *

In the discussion following the paper read by Mr. Frederick W. Winter before the Mechanical Section of the Engineers' Society of Western Pennsylvania on some facts concerning patents, the point was brought out that in patent law the product of a machine cannot be regarded as a part of the machine. As an example, a device for sugar coating pills in a medicine factory was quoted, which consisted of a box connected with an air pump, the top of the box being perforated with holes somewhat smaller than the pills. The pills were distributed over the top of the box, one on each hole, and then by exhausting the air pressure within the box, the pills were firmly held in position so that the box could be inverted into the sugar coating solution, but this device is not patentable *per se* for the reason that the product of the machine cannot be made an element of the claim of the patent, and it is said that the Patent Office has never recognized any exception to the rule. However, it is declared that the phraseology of a claim may be so worded as to evade the rule, inasmuch as it would not include the pill as an element in the claim.

SOME FACTS CONCERNING PATENTS.*

FEATURES OF OUR PATENT SYSTEM ABOUT WHICH INVENTORS SHOULD BE INFORMED.

The patent statutes of the United States are based upon Article 1, Section 8, of the Constitution, which provides that Congress shall have the power to promote the progress of science and useful arts by securing for limited times to inventors the exclusive right to their respective discoveries.

This constitutional provision gives the underlying principle of our patent statutes, and shows that the reward of the inventor is not the primary object aimed at, but it is a necessary incident. The framers of the Constitution perceived that the progress of science and the useful arts could best be promoted by furnishing an incentive to make improvements, and that the best incentive is some personal reward or advantage to tho inventor. Accordingly an inventor for a certain period is given an exclusive right to his inventions and discoveries; that is, a monopoly. As a consideration he is required to describe and illustrate the invention in his patent specification and drawings so fully and clearly that a person skilled in the industry to which the invention relates can make and use the invention; to the end that after the monopoly has expired, the public will be able to use and derive benefit therefrom. Therefore an inventor applying for a patent must disclose his entire invention, the principle thereof, and the best manner of applying the same. He cannot withhold any part thereof; otherwise the patent will be void. If he wishes to keep the whole or any part of his invention secret, the patent statutes give him no aid. This statement is ventured because the writer has been asked to secure patents for inventions which the inventors did not care to disclose fully even to their attorney. Clearly all such efforts are futile.

What is Patentable.

The statutes provide for the grant of patents for new and useful arts, machines, manufactures, compositions of matter, improvements, and designs:

Art. The term "art" covers what are ordinarily known as methods or processes, where the improvement consists in the manner or mode of accomplishing the result, as distinguished from the mechanical appliances necessary for this purpose.

Machine. The term "machine" is self-explanatory.

Composition of Matter. The term "composition of matter" covers all mixtures of several ingredients, whether chemical combinations or mechanical mixtures. Soaps, powders, paints, etc., are examples of well-known compositions of matter.

Manufacture. A "manufacture" in the meaning of the patent statutes is anything made by the hand of man and which is subject to manufacture and sale. This term is a broad and elastic one, and the interpretation given to it by the courts bring within it all inventions which cannot properly be classified under the other heads.

Improvement. The term "improvement" in the statutes is largely superfluous, for in a sense every improved device is a new device; or, *vice versa*, most new devices are merely improvements over prior devices. In the history of our patent system there have been but few generically new devices or processes.

Design. The term "design" in the patent statutes has a different meaning from what it has in engineering, where it is often used to mean a new plan or arrangement of mechanical parts for getting new or improved functions. For instance, a new design of motor is a new motor. All such matters in the eye of the patent statutes are subjects for mechanical, and not for design patents. The term "design" in the statutes is limited to matters of ornament or configuration appealing to the aesthetic sense and not to utility; such as a new design for spoons, jewelry, vases, and the like.

Utility.

An improvement to be patentable must be useful. This does not mean that the device must be more efficient or economical than prior devices of the same character. It is useful within the meaning of the statute if it is capable of producing a result, and that result is a good one, even though it may not be an advance upon prior devices of the same kind. The degree of utility is not inquired into by the Patent Office. If a device is incapable of producing any result whatsoever, it is inoperative and not patentable. So, too, if the device is injurious to morals, health, or good order of society, it is not "useful" within the meaning of the patent statutes. Upon this ground the Patent Office refuses to grant, and the courts refuse to sustain, patents for deleterious compositions and compounds of food products and the like, and for devices which can be used only for immoral or unlawful purposes. The more completely such an invention could perform its functions the more objectionable it would be for want of utility If, however, a device is capable of a good result it is patentable, even though it may be used for some unlawful or immoral purpose. The evil in such case is not inherent in the invention, but is a fault of the user, for which the latter, and not the inventor, should be punished.

Subject to the exception in regard to the utility of an invention it is a general rule that all changes or improvements, whether mechanical, electrical, chemical, structural, or otherwise, in a method or process, tool, machine, appliance, device, manufactured article or composition of matter in all arts, are patentable, provided they are new and are the result of invention. The statutory classes of invention have been given a sufficiently broad and elastic interpretation to cover the whole range of human activities and industries.

Invention.

As to what constitutes invention no general rule can be laid down. There are many improvements which are the natural result of the advancement of an industry which are suggested by many persons whenever the occasion demands. There also are many changes which are merely the expected skill of an ordinary mechanic working in those lines. All such changes are not "inventions" within the meaning of the patent statutes, and are not patentable. In general, invention may be said to consist in bringing forth that which theretofore was hidden to persons skilled in that particular art. The amount of change necessary to constitute invention may be very small, or may be required to be quite radical, depending upon various factors, but principally upon the advantages and results following from the change. If the benefits are very great, and the public and manufacturers are anxious to adopt the improvement as soon as known, it will be held to show that even a very slight change was the doing of something which before was hidden, and hence to be an invention. On the other hand, where there is no marked resulting advantage, the courts reqnire a greater degree of change in order to find the presence of invention.

Novelty.

The question of the newness or novelty of an invention is purely one of fact, and one upon which no opinion can be expressed without a detailed knowledge or examination of the art to which the invention relates. Under the statute, an invention is not new if it was:

1. Patented in this or any foreign country before the applicant's invention or discovery thereof, or more than two years prior to the application for patent;

2. Described in a printed publication in this or any foreign country prior to such invention or discovery, or more than two years prior to the application;

3. Known or used in this country prior to such invention or discovery, or

4. In public use or on sale in this country for more than two years prior to the application.

It follows that knowledge or use of an invention in a foreign country does not affect a patent granted in this country, unless such invention was either patented or described in some printed publication. Novelty can be determined only by an examination of all prior patents, publications, and uses in the same and analogous classes of inventions. This, to be thorough, covers a very wide range.

Term of Patent.

All mechanical patents are granted for the uniform term of 17 years. This is not now affected by the existence of any prior shorter-term foreign patents for the same invention, the only requirement being that if a patent is first taken out in a foreign country, the application in this country must be

* Abstract of address delivered by Frederick W. Winter before the Mechanical Section Engineers' Society of Western Pennsylvania, Dec. 1, 1904.

filed within twelve months after the filing of the foreign application. The term of seventeen years can be extended only by a special act of Congress, and this has not been done in any case, and is not likely to be done. In case there is a material error in the patent, or if it is inoperative or invalid by reason of a defective or insufficient specification or claim, it may be reissued, but such reissued patent will continue in force only for the unexpired term of the original patent. Design patents are granted for terms of three and one-half, seven, or fourteen years, at the option of the applicant. He must make his selection of the term at the time he files his application. It cannot be made thereafter.

The Right Granted by Patent.

All patents give an exclusive right during the term of the patent to (1) make, (2) use, and (3) sell the invention covered thereby. Infringement, therefore, may occur either by making, or by using, or by selling the device. Where one party manufactures a patented device, another party sells it, and a third party uses it, they are each liable for the entire infringement, and the patentee can choose which of the three he will sue, thus being able to select the one most able to respond in damages.

Patent rights extend to all of the United States and territories, but not beyond the same. *Vice versa*, patents granted in foreign countries give no protection in this country. Therefore it is no aid to the protection in this country to also take out patents in foreign countries. The seller or user in this country of an article manufactured abroad will be liable for infringement of any United States patent covering said article.

A patent gives an exclusive right only for that which is distinctly claimed. If no sufficient claim is made, the courts will give no relief, even if the invention is exceedingly valuable. The utmost care should therefore be exercised in drawing the claims of a patent. It is possible to so restrict the claims for a very valuable invention that it will be easy for others to devise forms of apparatus which accomplish the same result but do not infringe the patent. The claims should cover all possible mechanical embodiments of the principle of the invention, so that others, even though they originate new mechanical constructions or combinations, cannot avoid infringement.

Patent claims usually are drawn to combinations of the various elements which constitute the new device. Infringement does not exist unless all elements of the claims are employed by the defendant. In other words, the combination of a claim must be used in its entirety or else infringement does not exist. It is therefore essential that the claims, or at least the broad claim, should contain no element or limitation which is not absolutely essential to the principle of the invention. Brevity in patent claims is desirable.

Several Claimants for Same Invention.

It is never absolutely certain that a patent can be obtained until it is actually granted. Several parties may apply for a patent on the same invention, and in that case the applications will be put in what are known as "interference" proceedings, in which the parties will be required to take testimony to prove who is the first inventor, and the patent will be granted accordingly. The first inventor is the person who first perfected the invention and put it into a form capable of actual use, or, as it is technically known, "reduced the invention to practice." The best evidence of a completed invention is an actual commercial use thereof. But there is a rule that the filing of an allowable application for patent is a "constructive reduction to practice" and has the same force and effect in a contest on priority of invention as an actual commercial use.

While the general rule is that the first inventor is he who first reduced the invention to practice, an exception is recognized in favor of a party who was the first to conceive the invention, but the last to reduce it to actual practice, provided he was using reasonable diligence in perfecting and adapting the same. What constitutes reasonable diligence depends upon the particular circumstances of each case. The means at the command of a person, his employment, and other surrounding circumstances, his health, the complication of the invention, and cost of perfecting it, are all factors which enter into this question. What the law requires is reasonable, and not the utmost, diligence. But the Patent Office does not look with favor upon delays, and it requires a good excuse in all cases. The theory is that the party who first adapts an invention for actual use should not be barred by the stale claims of a prior conceiver who has slept on his rights.

Even after a patent is granted another party may file an application for the same invention and be put in interference with the patent. If he is able to prove, by evidence which does not admit of a doubt, that he first completed the invention, a patent will also be granted to him. The Patent Office, however, cannot call back or annul the patent first granted. It will merely be decided that the patentee was not the first inventor and a patent will be granted to the applicant. The Patent Office has no jurisdiction over a patent after it is granted except to declare an interference between it and a subsequent application, or to grant a reissue of the patent in case it is invalid or inoperative by reason of a defective or insufficient specification.

Patent does not Guarantee that Invention Can be Used.

The grant of a patent is no indication that the device covered thereby can be used without infringing prior patents. This is a point upon which much misunderstanding exists. Many persons assume that because the Patent Office grants a patent, the patentee has a perfect right to use the device covered thereby. This is an error. The Patent Office does not pass upon the question of infringement, but merely decides whether the applicant has made a patentable improvement over prior devices. Most patents cover mere improvements upon prior devices, and it frequently happens that there are still in force prior patents which cover fundamental principles of the device, and which will be infringed by the improved device, if the latter performs the same function by the same or equivalent means. To illustrate: The original Bell patent covered the fundamental principles of transmitting speech electrically. Within a few years thereafter, and during the life of that patent, others invented and patented many different forms of transmitters which were improvements upon the transmitter shown in the Bell patent. These improvements were clearly patentable; but they were just as clearly infringements of the Bell patent, because they of necessity operated on the principle covered by that patent. But in many arts to-day the existing patents are limited to such specific improvements that other improvements do not infringe.

All patents are *prima facie* valid. They may, however, be invalid for many reasons. The examiners in the Patent Office are human and liable to error. They also have not available the material for all grounds upon which a patent might be refused or invalidated. Patents can be refused upon publications or descriptions of the invention in scientific and technical journals or books in all languages. The Patent Office has not files of many publications, and many which they have are not available within the limited time in which the examiner must dispose of a case. So, too, a patent may be refused upon a prior use of the invention in some remote part of the United States, and which may be known to only a limited number of persons. Obviously, the Patent Office is not in a position to know of all uses.

There are, therefore, many elements entering into the validity of a patent upon which the Patent Office passes no opinion. A more extended examination through periodicals and prior uses than it is possible for the Patent Office to make, will frequently show either that the patent is entirely void or that it must be so restricted that infringement can be avoided.

Who May Obtain a Patent.

It is essential to the validity of a patent that it be granted on an application signed and sworn to by the original and first inventor or inventors, or by his or their executors or administrators. No other person, even with the consent of the inventor, can sign or swear to an application that will support a valid patent. The Patent Office has no means of ascertaining these facts and will necessarily be governed by the oath of the application. Should it, however, afterward develop that the party making the application was not the inventor, the patent will be invalid. The fact that a person furnishes capital, machinery, or material for developing the invention, gives him

no right to make or join in the application for patent. Such person may acquire an interest under the patent, but this can only be done by an assignment executed by the inventor and transferring to him the whole, or any fractional portion, of the entire right to the invention and to the patent. If such assignment is recorded in time the patent will be issued to the assignee or jointly to the assignee and the inventor, as the case may be. The builder of a new machine or device is not the inventor if he did not himself originate the ideas or principles contained in such device. In other words, an inventor may employ others to construct and mechanically perfect his invention without losing his exclusive right thereto, and without giving the mechanic who constructs it any right to the patent, unless it has been agreed upon by contract between the parties. Even in that case the mechanic will take his right only by reason of the contract and under a properly executed assignment. If a person conceives the general plan of an invention and employs another to construct and perfect the same, and the latter under such employment originates improvements which are included in, or, as the court said in one case, are ancillary to, the general plan, such improvements nevertheless belong to the person furnishing the general plan and can be included in any patent for which he may apply.

Patent Rights Between Employer and Employe.

Employes as well as employers are entitled to their own inventions and to patents granted therefor. This right can be modified by contract, but in the absence of a contract to the contrary an employe is entitled to a patent for any invention which he makes, even though it may relate to the business of his employer. If he develops the invention in the time, and at the expense, and with the tools and material of his employer, then the latter will have an implied license or shop-right to use such invention in his business, but he cannot demand an assignment of the patent. Employers who wish to secure inventions relating to their own business, which are made by others while in their employ, should have a contract with the employe. Even with such a contract the employer cannot apply for a patent in his own name, but the patent must be applied for by the employe and assigned to the employer.

Joint Owners of Patents.

Patents may be owned jointly by two or more parties, and these may have different fractional interests. A common misapprehension is that one joint owner of a patent cannot make, use, or sell the patented invention without the consent of, and without accounting for profits to, his co-owners. This is an error. In the absence of a contract to the contrary, any co-owner of a patent, no matter what fractional interest he may hold, is free to assign his interest in the patent, or to manufacture, use, and sell the patented device, or license others to do so, without the consent of his co-owners and without accounting for any part of the profits. If, therefore, a person owns merely a one-hundredth share of the entire patent right, he may manufacture, sell or use the patented device without the consent of, or accounting for the profits to, the owners of the other ninety-nine one-hundredths. By reason of superior facilities for manufacture, or superior business ability, he may even entirely monopolize the field so as to practically exclude his co-owners from deriving any income whatsoever from their share of the patent. He is nevertheless entirely within his right. The only way this can be prevented is by a properly drawn contract between the co-owners.

Application for Patent.

Only a small percentage of patent applications are allowed as first filed. Generally the officials find some objections against the specification or claims, generally the latter. It frequently happens that a patent is not secured until after repeated considerations. An inventor should therefore not be discouraged because in the first instance his application is rejected. The rules give ample opportunity for overcoming rejections either by amendment or argument, or both, or even appeal to a higher tribunal. But no new or additional matter can be incorporated in an application after it is filed.

Marking Patented Articles.

The owner of a patent must mark the patented articles plainly with the word "patented," or similar word, together with the date of the patent, or otherwise give sufficient notice to the public that the device is patented. The failure to so mark will prevent the recovery of damages for infringement occurring prior to actual notice of the patent to the infringer. No person should mark an unpatented article with the word "patent" or other designation which would leave the public to believe that the article is patented. For each such false marking, with intent to deceive the public, the marker is liable to a penalty of $100. While the application is still pending the manufactured articles can be marked "patent pending" or "patent applied for." This will warn the public, and in most cases will prevent infringement.

Caveat.

There is a common misapprehension that a caveat is a short term patent. On the contrary it is a mere notice to the Patent Office that the party has made an invention and wishes further time to mature the same. It continues in force for one year, and it may be renewed from year to year by the payment of the required government fee. If during the term of the caveat, or any renewal thereof, another person files an application for patent for the invention shown in the caveat, the caveator will be notified thereof and will be required to file his application within three months from the time of receiving the notice. The two applications will then be put in interference and testimony will be taken to prove who was the first inventor, and the patent will be granted to such party.

Foreign Patents.

The patent laws of no two countries are the same, and a device which is patentable in this country may not be patentable in foreign countries, and, *vice versa*, devices which are not patentable here may be patentable in some foreign country. In Germany it is difficult to obtain patents, the laws and their interpretation being very strict. Many of the small improvements which are patentable in this country find no favor under the German law. In other foreign countries, notably Belgium and France, no examination into the novelty or patentability of the invention is made, but the patent is granted as a matter of course. But this does not mean that the patent will be held valid, as it may be overthrown if it is found that the invention was not new in that country at the time the application was made. It is essential, therefore, in these countries that the prior state of the art be thoroughly investigated before the pateut claims are drawn.

The cost of obtaining a patent in most foreign countries is greater than in the United States, and the conditions of maintaining the patent are somewhat burdensome. In this country, no taxes or renewal fees are necessary, nor is the patentee even compelled to manufacture the patented device or put it into use. In most foreign countries the patents are subject to annual taxes or renewal fees. These vary in the different countries, being generally quite low the first few years of the patent term, but gradually increasing. Such taxes amount to a considerable sum in the aggregate, and if the patent is not producing a revenue they are a burden. So, too, in most foreign countries the inventor must put the invention to actual use in that country, or at least make such arrangements for manufacturing and so advertise the fact, that any person wishing to procure the patented article can be supplied. The manufacture of the articles in this country and importation into foreign countries does not comply with this provision of the laws of those countries.

In most foreign countries patents must be applied for before corresponding patents are issued in this or any other country. Canada is an exception, as patents can be applied for within a year after the issue of a patent in another country.

* * *

The importance of the rubber industry in the United States is indicated by some figures published by the Bureau of Statistics, which show that during the year 1904 nearly 62,000,000 pounds of india rubber were imported, of which 34,500,000 pounds came from Brazil. This importation is valued at $44,000,000, or 70 cents per pound, the price having increased to this figure from 43 cents, the price in 1884.

PUNCHING SMALL HOLES IN TOOL STEEL BLANKS.

JOSEPH V. WOODWORTH

Joseph V. Woodworth.

The tools described herein and illustrated by the accompanying drawings were used for the punching of five holes 0.050 inch in diameter through tool steel 1-16 inch thick. Now it will be conceded that the accomplishment of this work presented unusual difficulties, the exceedingly small diameter of the holes in comparison with the nature and thickness of the material worked upon precluding the use of tools of standard design and construction.

Fig. 1 is an illustration of the two parts for the piercing of which the tools were used. As will be seen from the black dots five holes were punched in each. The part shown at the right is a small dovetail piece of tool steel which is afterward riveted to the part on the left, thereby forming a slide which is used in a machine of world-wide use in printing and publishing concerns. After assembling by riveting, the article is hardened, tempered, and ground, and the dovetail surfaces are shaved to accurate measurements, the allowable limit of variation being only 0.0005 inch at any point.

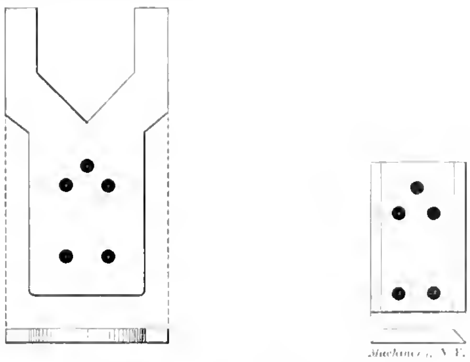


Fig. 1. The Pieces Punched.

Fig. 2 shows three separate views of the upper or punch section of the tools. The construction is such as to overcome as much as possible the tendency of such frail punches to buckle, snap off, or shear the dies, and is as follows:

D is the holder of machine steel in which are located and fastened the five punches, *A*; *E*, the adjustable backstop, for the punches to bank against; and *G*, the two die-aligning studs. *C*, the punch-supporting pad and stock-stripper combined, has five holes let through the face *B*, into which the punches fit snugly. Five filister head screws, *K*, fasten the punches in the seats in the holder. Two studs, *G*, are fastened and located in *D* in accurately-reamed holes by the two headless screws, *H*. Eight small coil springs—four of which are shown—located in countersunk seats in the holder and punch-supporting pad, keep the pad, *C*, tightly against the blank while the holes are being pierced; they also cause it to strip the blanks after each stroke. It will be seen that the construction of the punch throughout is such as to insure a perfect alignment with the dies, and to give a stiff and positive support to the five punches up to the point where they enter the stock. The two shoulder screws, *J*, prevent the combined supporting pad and stripper, *C*, from descending too far.

The lower section—the die—is shown in Figs. 3, 4 and 5. Figs. 3 and 4 are plan and side views respectively; and Fig. 5 shows a vertical cross-section. The construction is interesting.

L is a bolster of machine steel, *R* the die in which the piercing dies are contained and which are indicated by black dots in the plan view. The manner in which this die is fastened and located within its seat in the bolster so as to remain positively fixed is shown clearly in Fig. 5. A keyway

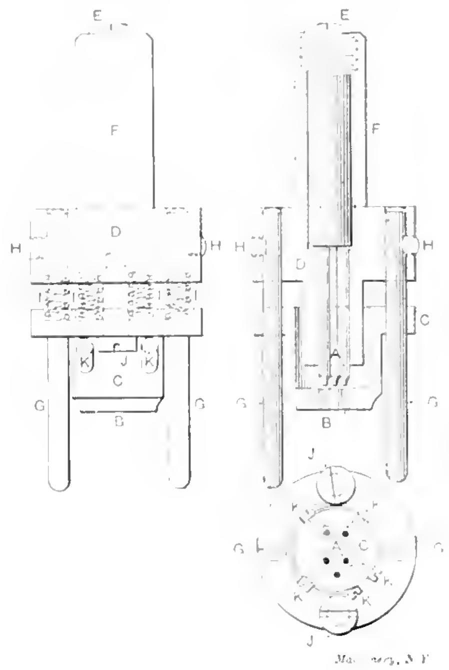
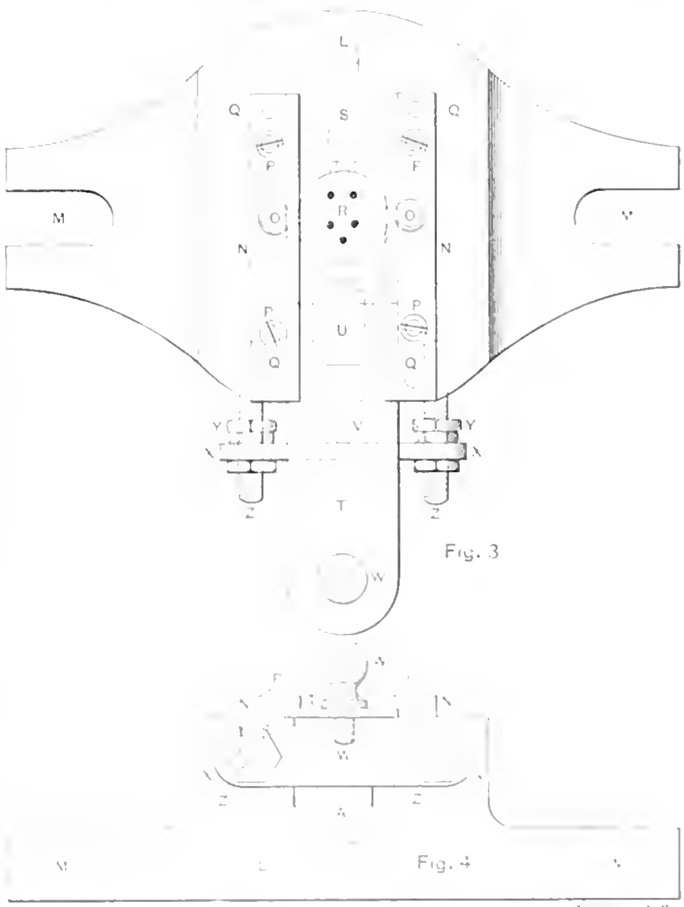


Fig. 2 Construction of the Punch Holder

is let into one side of the die, *R*, which is engaged by the key-ended stud, *S*. The hole, C_1, in the bolster, is tapped from the under side for the greater part of its length for the hollow headless screw, B_1, upon which the die, *R*, rests. Thus, when it is necessary to grind the die face of *R*, the headless set-screw, B_1, is utilized to force the die to a height even with the surface of the bolster.

Returning to the views, Figs. 3 and 4, *N* are two tool steel gibs in which the slide, *T*, for locating the work on the die



FLAN AND SIDE ELEVATION OF DIE

Figs. 3 and 4

JOSEPH V. WOODWORTH was born in Brooklyn, 1872. He received a high school education in the evening schools of Brooklyn, and took a mechanical engineering course with the International Correspondence Schools. He served an apprenticeship with the E. W. Bliss Co., and has worked for a number of the best die-making and special machinery manufacturing establishments in New York State, with which he has held the positions of tool-maker, die-maker, designer, foreman, and master mechanic. He is now holding the position of consulting engineer and reducer of manufacturing costs with the Mergenthaler Linotype Co., Brooklyn, N. Y. Mr. Woodworth has contributed many valuable articles on die-making and interchangeable manufacturing to MACHINERY and other trade papers, and has written three books, viz.: "Dies, their Construction and Use," "Hardening, Tempering, Annealing and Forging Steel," "American Tool Making and Interchangeable Manufacturing."

face, moves. These gibs have reamed holes at O for the punch aligning studs, G, to enter. The gibs are fastened and located on the bolster by means of four screws and four dowels, Q. X, Y, and Z, indicate parts of the adjustable stop which serves to adjust and fix permanent the movement of the slide, T. W is a small knob which the operator utilizes when working the slide back and forth during the punching of the holes. V is the stop-pin which prevents the slide from coming out too far from the gibs; and W_1 is the pin which prevents it from moving in beyond the proper locating point for the blanks.

When the tools are in operation the punch is set so that the two aligning studs, G, are in the holes, O, in the die gibs. The die is clamped in position, and the stroke of the press is regulated so that the aligning studs, G, do not leave the guide holes during the up-stroke of the ram. The operator then slips one of the small blanks shown at the right in

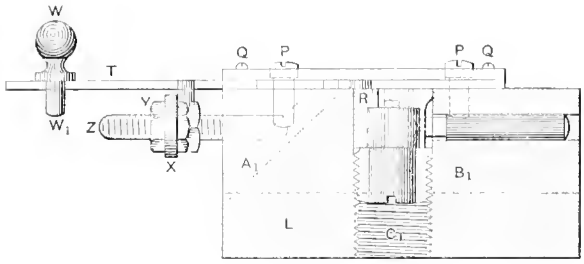


Fig. 5. VERTICAL CROSS SECTION OF DIE

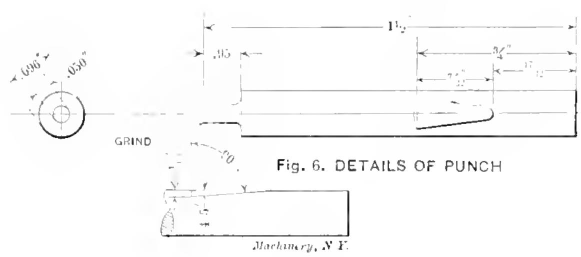


Fig. 6. DETAILS OF PUNCH

Figs. 5 and 6

Fig. 1 into the locating seat, U, in the slide, T, pushes the slide forward until the pin, W_1, rests against X, and then he steps the press treadle. On the up-stroke the work is stripped from the punches by C and remains in U. The operator pulls the slide back, and the blank drops into the exit chute indicated at A_1 in Figs. 4 and 5.

Fig. 5 shows detail drawings of the punch. These punches are made in lots of five hundred at a time, from drill rod of the exact diameter of the punch shanks; a small accurate box tool in the screw machine turret reduces the punch ends to size.

Over 100,000 blanks of both shapes shown in Fig. 1 are used per year in the works where the tools shown are used. To use the tools for punching the five holes in the larger blank shown at the left in Fig. 1, a different slide is substituted for the one used for the small blank.

* * *

THE USES OF HIGH-SPEED STEEL.

G H B.

The writer has taken a good deal of interest in the method of using, treating and grinding high-speed steels. The first thing is to make up one's mind as to the quality or kind of steel to use, which means to be satisfied with the steel which has been found to work best in one's own shop. This has been a difficult matter for superintendents and foremen to decide, because it is so hard to discover the best way to determine which steel will do the most work, and experience has taught most of us that any of our high-speed steels, when properly treated, will do considerably more work than the machine is capable of.

I do not think it advisable to have too many different kinds of stock in the works; results depend entirely upon the way of forging and treating the tool. If the toolmaker is familiar with one or two grades of the best high-speed steel, and the quality is found satisfactory, and bringing about the best results that the machines can stand up to, these are the steels that should be adopted. Each of these steels must be treated differently, and if the toolmaker succeeds in treating one grade properly and understanding it thoroughly, it means much time saved and better results in the shop.

In introducing the use of high-speed steel in a shop, like everything else that is to be a success, one must start right. That is, the work should be undertaken by some responsible person—superintendent, foreman or speed boss, in other words, the man who is responsible for the work turned out in the machine shop. All tools, of course, have some particular way of treating, which should be understood by the person in charge. Now it is "up to the forger." The person in charge should see that the tool has its proper treatment, as success in most cases lies with the treatment. When the tool is finished, and the superintendent or foreman is satisfied that it has been properly treated in accordance with directions, it is ready for grinding and for making a test. It should be ground on a wet emery wheel, and care taken to heat the tool just so it can be touched with the fingers.

The tool once ground and ready to do the work, the question often arises, "What lathe, planer or machine are we going to put it into?" In most cases when a new tool is tried, it is put in a lathe, to do turning; so naturally the superintendent or foreman would pick out the best lathe that was in the shop, *i. e.*, the lathe that was considered to have the most power. Being now ready to make the test, it is generally tried on steel; that is considered by most superintendents and foremen the severest test to make. Take a piece of steel of almost any diameter, and of the quality most used in the shop, and prepare to take the cut. It seems to puzzle most every foreman to know just what to do and where to start. I speak now of what I have seen, and of the men who are sometimes sent by the steel makers to demonstrate the use of their steels. I think the proper way is to get at least one dozen shafts of a standard size that are used in the regular line of product, and to first look up the exact time it took to finish or rough off the previous lot; then to determine about what percentage of time would be considered a fair gain to warrant adopting the steel, based on the price per pound of the steel being used. Let it be based at 25 per cent, which I find in most shops can be accomplished, and the lathe be speeded up faster than when the last lot was turned, starting with the same feed and about the same cut, which most any lathe will stand. The superintendent finds, after he has roughed off about two or three pieces, that the tool seems to stand up all right. The next step is to find out about the speeds and feeds. The first thing is to increase the feed with the same speed the machine is running at. In most cases which I have seen, after the tool had traveled a certain distance the cutting edge would break or crumble, and the foreman would say, "Just as I expected. All this high-speed steel will do the same thing." forgetting he had just been doing over 25 per cent more work than ever before, without the least bit of trouble.

Now the tool is taken out and looked over, and it is found that a portion of its cutting edge has been broken off. Here is where most foremen make a mistake; they take the tool back to the forger or tool dresser to have it re-dressed and treated over. If it is only broken off slightly and can be ground, even if it take ten or fifteen minutes to grind, it should be done by all means. My experience has taught me it will prove a better tool than before, but care must be taken not to overheat in grinding.

The tool is now put back in the lathe, which is started again; and generally, to one's astonishment, it will be found that the tool will stand up all right. One should not be too anxious to break the tool again (!), but should turn up two or three more pieces with an increase of feed, keeping a record of the time it takes to turn up each piece. Once convinced that the tool will stay up all right with the increase of feed, the foreman can increase the speed one step on the cone. About the time this is done, it is found either that the belt slips, the lathe is stalled, or the countershaft will not drive. (It is my opinion that in most all machines which have been built up to a year or so ago the countershafts are not strong enough in comparison with the machine tools.) Now, no doubt if these things had not occurred the tool would have

done better; but in this case, reduce the speed, and finish the twelve shafts, which it will probably be found can be done without grinding the tool. When the shafts are all roughed off and finished, the foreman will find to his great astonishment that by actual time the lathe has produced over 25 to 40 per cent more work than ever before. I allude to the lathe using most all ordinary tool steels.

At this point it is up to the superintendent to see just where he is at, and he finds in looking around his shop that there is hardly a machine that he can't speed up, but he also finds that the speeds on the countershafts are all too slow. This means that he has either got to increase his speed by increasing the main line, or buy new pulleys to increase his countershafts. In most instances it is advisable to increase the speed of the countershaft, but by doing this he generally finds that the countershaft will not stand the speed. If the machines are not too badly worn out, and he is satisfied that he can get at least 25 per cent more work out of the tool by increasing the counter speed, by all means let him get a new countershaft and treat each machine this way.

No doubt the readers of this article will know the results that some of us have arrived at in the last two years. In regard to cutting speeds and feeds there has been and always will be difference of opinion, and it is almost impossible to determine the right feeds and speeds, whether it is for steel or cast iron, and for the operations of turning, planing, or milling. The work varies so in different shops; that is, regarding the construction of different pieces, the amount of metal there is to remove from each piece, and how accurately the work has to be done.

There is no doubt in my mind that the makers of high-speed steel have awakened the management of different shops, and it is surprising the amount of work which can be accomplished even with the old machines, with very little redesigning. There is no question but that the machine shops which do very heavy work have not the necessary power for the use of high-speed steels, as the power should be used if the machines are old ones. Referring again to the question of grinding, I wish to state that this is a very important factor in the use of high-speed steels. I have seen much damage done to the tools, in many instances making it necessary to treat them over, and as we all know, this takes much time. My recommendation for grinding is to let one man grind all the tools, and be responsible for them. When a lathe hand or a machine hand wants his tool ground, he simply gives it to the man who is responsible, and gets another the same size and shape, these being always kept ground and ready for service. In this way the tools are kept uniform and ground alike.

In reference to the amount of work that can be accomplished on different machine tools, the writer finds that the feeds have been altogether too fine on most makes of machines up to the time that they were redesigned for high-speed work. Now it has been demonstrated that high-speed steel has come to stay, and we all know that it works better on roughing work than it does on finishing. If most of the product of the machine department is to be turned, it has come to the point where the majority of work must be ground; and this is the only way to get good and accurate work, especially where the strains of the cut spring the work. Moreover, as it is not necessary to straighten the work to any great extent, it certainly means a great saving, as many of our readers know. The writer is not a builder of grinders, but merely speaks of the saving it has been on his own work.

Below is a fair average of the speeds that most any good make of lathe, planer, drill press or radial ought to stand when using high-speed steel. Every lathe has a faceplate about the diameter of the swing or very near that. Take the periphery speed of same by feet per minute; the use of a Warner cut-meter will give you the speeds instantly. This is one of the handiest little tools that can be obtained, and no machine shop is complete without it. The speed must be taken with the belt on the largest step of the cone, with the back gears in. The speed of the following sizes of lathes, taken from a large faceplate with the slowest speed, I find to work very well, and considerable saving has been effected even on old lathes. Of course the feeds will have to be determined by the amount of power available:

LATHES

14"	swing	lathe;	slowest	speed	with	back	gears	in,	100	feet
16"	"	"	"	"	"	"	"	"	90	"
18"	"	"	"	"	"	"	"	"	85	"
20"	"	"	"	"	"	"	"	"	75	"
24"	"	"	"	"	"	"	"	"	65	"
30"	"	"	"	"	"	"	"	"	60	"
36"	"	"	"	"	"	"	"	"	50	"
42"	"	"	"	"	"	"	"	"	30	"

Larger lathes in proportion.

PLANERS

20 x 20	travel	of cut,	40	feet.
24 x 24	"	"	38	"
36 x 36	"	"	35	"
48 x 48	"	"	30	"

Larger ones in same proportion.

If you have the power in your planers the speeds ought to work on soft steel as well as cast iron.

High speed twist drills, drilling cast iron, ought to drill the following, if you have the power and feeds:

1/2"	diameter,	speed	500	r.p.m.,	3 1/4"	deep	in	one	minute.
5/8"	"	"	400	"	2 3/4"	"	"	"	
3/4"	"	"	325	"	2 1/2"	"	"	"	
7/8"	"	"	290	"	2 1/4"	"	"	"	
1"	"	"	250	"	2 1/4"	"	"	"	
1 1/8"	"	"	220	"	2 1/8"	"	"	"	
1 1/4"	"	"	200	"	2"	"	"	"	
1 3/8"	"	"	185	"	1 7/8"	"	"	"	
1 1/2"	"	"	175	"	1 3/4"	"	"	"	

Larger ones in proportion.

These speeds are all based on a periphery speed of 65 feet per minute. High-speed drills have done somewhat better than this, however, but taking into consideration the time of grinding, I find that this speed is a good average during a day's run.

* * *

OF HISTORICAL INTEREST.

We have received from Wilfrid B. Ward, Richmond, Ind., a brief but interesting account of his grandfather's old shop in Philadelphia, built in the latter part of the eighteenth century, which we publish below:

Mr. Thomas Barritt (my grandfather) served an apprenticeship between the years 1792 and 1797 with John Stowe, who had a shop on Bread Street, near Second, where they did wood turning, also turning in iron. Later, after he had finished his apprenticeship he married his employer's daughter and set up for himself in a shop on Front Street, between Vine and Callowhill, where he took up the turning of metals and apparently did a good business. In 1801 he invented a threshing machine for grain for which he received a patent in 1804 which bears the signatures of Jefferson, President, and Madison, Secretary of State. In 1822 he invented a machine for tarring ship cordage, for which he was presented with the John Scott medal by the "Philadelphia Society;" also a machine which we think was the first mineral water machine. This he took to Washington and it proved a complete success. He also brought out a machine for finishing silk hats, for which invention he was rewarded by having his house mobbed by the men whom it threw out of work. He turned the capstan of the first 74-gun ship that left the navy yard, and I have a record of some large screws turned for the water works in 1810.

He constructed the Readhefer perpetual motion machine which took up about all the space the old-time magazines had to spare; at least my old books seem to have devoted a great many pages to a discussion of its merits.

Mr. Eschol Sellers in a letter written a few years ago, mentions my grandfather's shop, but he was only a boy at that time and did not remember much about it. I have a receipt of Jacob Frick for brass castings, amount $56.40; so I presume he ran no foundry in the year 1820. Also an account of the laying of water pipes in New Market Street in 1826 for which his amount to pay was $27.50 for 34 feet. Mr. T. Bryant was water works superintendent at that time.

* * *

Bells are cast of a mixture of three parts copper and one part tin. It is said that the bells of old Nineveh were of this composition, which, if true, would make the formula almost as old as the known history of man.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

MACHINERY

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

APRIL, 1905.

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Including 600 advertisers' copies, as part of their contracts.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

One of the doubtful joys of an editorial position on MACHINERY is answering the questions of correspondents. While there is always a decided satisfaction in imparting information of which you are reasonably sure, or of which verification can be found in some so-called authority or work of reference, the trouble with answering the questions propounded by MACHINERY readers is that they are usually far beyond the kindergarten class, and the answers are more or less uncertain unless one has had special experience on information in that particular line. There is, however, no better sharpener of wits than the searching out of information of a definite character, even if it is of comparative inconsequence, and for this reason we welcome all the questions that may come, being assured that we will derive fully as much benefit from the labor incurred as will the correspondent in the answer received. Therefore, come ahead with your questions, and we will "make a fist" at answering anything that directly relates to the mechanical interests of the majority of our readers. Incidentally, we cannot help being impressed by the lack of information on a variety of subjects and the poverty of many mechanical works when it concerns other than what might be called the academic side of mechanical engineering. Therein lies the great difference and value of a publication like this, which, while necessarily behind the "state of the art," follows it much more closely than can any book.

* * *

OUR RECORD OF NEW TOOLS.

In the department "Machinery and Tools," which appears in our columns each month, will be found the most complete and convenient summary of new appliances for the machine shop that appears in any publication. The items in this department are used strictly because of their news value and not because of any advertising consideration. It is our purpose to list and, in many cases, to illustrate new machine shop products when they are placed upon the market, for the convenience of purchasers of such machinery. The amount of space and the number of illustrations accorded to any machine depend, as a matter of course, first upon the novelty of the machine, and second, upon the completeness of the information sent to us. It would not be of interest, for example, to show a number of illustrations of a lathe which, in the arrangement of its parts, was substantially a standard article, similar in its essential features to what had been manufactured for many years. When a machine is more or less of a standard character, the best that can be accomplished by our department is to give a general view of the machine, showing what its appearance is, and to accompany it by a few brief specifications, sufficient to convey to the reader an idea of the machine's proportions and of the work that it is able to do. The illustrations used in such articles are made as small as is consistent with the details of the parts appearing in the illustration, the size depending also somewhat upon the appearance of the printed page on which the engravings are arranged. It obviously is not possible to make the different machines appear in their true relative proportions; as for example, a boring mill and a surface gage, which could not be assigned space corresponding to their dimensions. We have sometimes received complaints because such and such ones have had larger engravings than others, and while we undoubtedly err occasionally in proportioning the sizes of engravings, we think the average reader will understand that the size of the cut is intended to be no criterion of the value of the machine. We simply aim to publish a concise illustrated record or list of new products, arranged for convenient reference, and if this department of the paper accomplishes this end it will fulfil its mission.

* * *

A MAN'S BRAINS ARE HIS OWN.

The courts do not look with favor upon such contracts with employes for inventions as can be construed as "a mortgage upon the man's brain." For this reason when a contract is made between an employer and an employe by which the former is given rights in the inventions relating to his business that the latter may make, it is necessary, in order for such contracts to be sound and valid, for it to be very carefully drawn, and its scope must be accurately defined; it must state what particular inventions are to be the property of the employer, and it should also state what compensation is to be given the employe. While wages or a salary might be considered as a compensation, it is not generally so considered by the courts, unless it can be shown that such wages include an extra allowance which is regarded as compensation for the inventions made by the employe, or that the wages are paid the inventor as such and not as an ordinary workman. In other words if a man is hired as an ordinary draftsman and during his period of service he makes an invention relating to his employer's business which is not incorporated in the results of his regular work his employer has no claim on it. But if he is hired as a draftsman to plan, devise and improve the machines the complexion is changed. A contract which includes all past, present, and future inventions would be invalid, or if it is for "all inventions which the employe may make" it would not be sufficiently specific. But if Jones is building a line of shoe-making machinery, he can contract with Smith to improve this machinery, and all inventions that Smith shall make during his period of service relating to shoe-making machinery would properly be the property of Jones. If during this period, however, Smith should invent an electric motor, Jones would have no claim whatever upon it, provided Smith could show that this invention was made and developed outside business hours. On the other hand, if he developed the motor and made the drawings in Jones' office, and received pay for the time spent in doing such work, Jones would have shop rights in the invention, but no control of it outside of his shop.

* * *

Certain features of interest in regard to the Panama Canal and the work now in progress on the Isthmus will be found in another column, in a report of the last monthly meeting at the rooms of the American Society of Mechanical Engineers, at which Mr. W. R. Warner, of the Warner & Swasey Co., and Prof. Burr, of the Panama Commission, gave interesting talks. It may be added in this connection that any mechanics who wish to seek employment at Panama during the construction of the canal can obtain full particulars as to conditions, examinations, vacations, transportation, etc., by applying to the Civil Service Commission, Washington, D. C. The employment of help on the Isthmus has been placed under civil service regulation and will be on the basis of competitive examination.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Prof. William G. Raymond, of the University of Iowa, has prepared data showing conclusively the tendency from arts to engineering courses in American colleges. From the attendance rolls of eighteen leading colleges, which offer both engineering and arts and science courses, it appears that the attendance in arts and science has increased in four years 15 per cent, and in engineering, 102 per cent. These figures include only regular students, and the record for the arts and science attendance includes many women students.

Various metals which are themselves non-magnetic may form alloys which display magnetic qualities; some of these have been produced in recent experiments. Aluminum, copper and manganese are all non-magnetic, but when combined in certain proportions an alloy of considerable magnetism is produced. As no alloy of copper and aluminum alone is magnetic, this effect must be ascribed to the manganese, and yet this metal alone, as well as copper and aluminum, remained non-magnetic when cooled to the temperature of liquid air. An alloy of manganese with iron is practically non-magnetic, but with the same manganese a magnetic copper alloy can be made.—*Engineering Review.*

New York City is shortly to embark in an interesting experimental enterprise, namely, an attempt to run a crematory in connection with an electric lighting plant. In Great Britain, we are told, city refuse has been used successfully for steam raising and also in Hamburg, good results having been obtained from a combined destructor and electric plant, but in this country no practical data have as yet been obtained. Hence original designs will largely have to be gotten up for the New York plant, which fortunately, perhaps, will be on a comparatively small scale. In all probability an attempt will be made to combine refuse and coal in some proportions, or to depend for steam partly on coal as well as on refuse. This experiment will be watched with great interest.

The problem of rapid rail wear on sharp curves is a serious one with the Boston Elevated Railway on which line there are eighteen curves of less than 100 feet radius, and sixteen other curves of less than 150 feet radius in a total of sixteen miles of track. On one curve of 82 feet radius an ordinary commercial steel rail weighing 85 pounds per yard lasted only 44 days, the wear in that time being 0.6 to 0.77 inch, according to the statement of Mr. H. W. Steward in a paper read before the New England Street Railway Club at Boston. Nickel steel rails were next tried, but these wore at the rate of 0.53 inch in 204 days. Manganese steel rails are now being used, and the wear in 1,000 days has been a little less than 0.2 inch. Manganese rails are very costly, the first cost being about $5 per foot, as against thirty-eight cents for ordinary steel. Manganese steel can be bent cold but cannot be cut cold with ordinary track tools.

The three great power stations now being built on the Canadian side of Niagara Falls will have an aggregate output of 285,000 H. P. In addition to the above, the Ontario Power Company intends increasing its power ultimately by 120,000 H. P., so that the total output for the new Canadian stations will then be 405,000 H. P., which is more than 27 per cent of the world's present hydro-electric power, computed at 1,483,000 H. P. On the American side there is about 150,000 H. P. in the three stations. On the Canadian side, along the old Welland Canal, there are two stations having at present 26,000 H. P., with a total planned for of 52,000. The total for the district will then be over 600,000 H. P. While it is said that the Niagara Falls region is not likely to make use of more than 400,000 H. P. for at least a generation to come, still this amount is sufficient to play a very important part in industry, whatever its effect may be upon the grandeur of the Falls.

A new incandescent lamp in which the incandescent filament is tantalum, a rare metal, in place of carbon, has been produced as the result of two years' experimenting at the Siemens & Halske Electric Works in Germany. The tantalum, which has to be worked in vacuum, is somewhat harder than mild steel and has a tensile strength considerably greater. Tests have resulted in a commercial form of lamp which takes 1.7 watts per candle power as compared with three or four watts per candle power with the ordinary carbon filament. In order to get sufficient resistance for a 110-volt lamp, a filament 2½ feet in length has to be used. This is mounted by running the tantalum filament back and forth between a lower and an upper star-shaped support, so that the lamp is not much bigger than the carbon filament lamp. The incandescence is high, so that the light is very white. The average useful life of the lamp is between 400 and 600 hours. No figures are yet available as to the first cost of the lamp, but if it can be manufactured cheaply enough, its great gain in economy over the carbon filament lamp should lead to its widespread adoption.

According to the authority of Mr. J. M. Gledhill, of Armstrong, Whitworth & Co., ordinary crucible steel containing 1.30 per cent carbon is suitable for small turning and planing tools, drills, small cutters, razors, and surgical instruments; 1.15 per cent carbon for heavier turning, planing and slotting tools, drills, cutters, reamers, and engraving tools; 0.90 per cent carbon for large circular cutters, reamers, taps, dies, heavy turning tools, and large drills; 0.80 per cent carbon for cold chisels, hot sets, small shear blades, and large taps; 0.75 per cent carbon for dies, cold sets, hammers, swages, minting dies, miners' drills, blacksmiths' tools, punches, and shear blades; and 0.65 per cent carbon for snaps, dies, drifts, hammers, and stamping dies. The steel that is suitable for making a razor is obviously totally unfit for a stamping die, although it is of much higher grade and more costly. Much of the trouble encountered in the average shop in the use of tool steel is that no record is kept of the carbon content of the various steels kept in the tool room, and very often an entirely too high grade steel is used for a purpose where one of perhaps half the carbon content would be much better suited. Some shops paint one end of all steel bars in colors and combinations of colors which correspond to an arbitrary classification. As these bars are used, the stock is cut off the opposite end, and the marked end remains until the bar is completely used up. Where this or a similar system is employed, a large part of the trouble of the toolmaker should be avoided.

When a coiled spring is mounted on a mandrel which fits it closely, it can be made to grasp the mandrel with great force by turning the opposite ends of the coil so as to close upon it. Advantage of this fact is taken in the design of a shaft coupling which makes unnecessary any keyways cut in the shaft. It is also used in the coil-clutch reversing gear used to some extent in rolling mills. The ordinary type of rolling mill requires that the engine be of the reversing type, and when the limit of rotation in one direction is reached the rolls are reversed by reversing the engine. This means that the valve gear must be of a simple type operated by link motion, and prevents the use of a more economical form of valve motion like the Corliss type. By the use of the coil-clutch reversing gear, the engine runs in one direction all the time, and therefore can be of the compound condensing type of high efficiency. The clutch includes two steel coils surrounding drums keyed on the shaft which has to be reversed. The outer end of each coil is fixed to a gear wheel, loose on the shaft, these wheels being driven continuously in opposite directions and carrying the coils around with them. Between the inner ends of the coils there is a sliding collar on the shaft which, when moved in either direction, comes in contact with the bell-crank lever, and tightens the last turn of the corresponding coil on the

drum. The motion of the gear wheel causes the coil to easily but firmly grasp the drum, and through the drum to drive the shaft. The action of reversal is not instantaneous with the coil clutch, hence it operates without shock. *Engineering* says that a copper rolling mill in France has been recently equipped with a train of rolls operated by an 800 horse power engine through one of the coil-clutch reversing gears made by the Consolidated Engineering Company, of Slough, England. The engine has a 46-ton flywheel running at 86 revolutions per minute, which gives great steadiness of operation to the rolls. The strength of the clutch is said to be so great that it is guaranteed to stand the tremendous strain of pulling up the engine to a dead stop should the rolls become jammed.

THE WEIGHT OF A CROWD OF PEOPLE.

Lewis J. Johnson recently read a paper before the Boston Society of Civil Engineers which was printed in the Journal of the Association of Engineering Societies, January, 1905, giving results of experiments recently carried out by him, which go to show that the data hitherto considered as standard on the subject of the weight of a crowd of people are in many cases far below the true figures. For instance, in Trautwine it is stated that people can hardly by any contingency on bridges, turnpikes, and common roads weigh more than 80 pounds per square foot. To compensate, however, for impact, Mr. Trautwine recommends the adoption of 100 pounds as the limit for crowds. The State building laws of this country specify 80 to 150 pounds for the minimum floor loads for public assembly rooms. Recent papers read before the American Society of Civil Engineers, however, have stated that 40 to 45 pounds per square foot is exceeded in practice so seldom as not to demand much consideration. In view of this statement, the experiments just undertaken by Mr. Johnson are especially interesting. He crowded men into a weighing box to such an extent that the maximum of 181.3 pounds per square foot was attained. This was the weight of forty men averaging 163.2 pounds apiece on 36 square feet, and was, of course, an unusual figure. However, if forty men weighing 163 pounds each can stand in no serious discomfort in 36 square feet, it is clear that forty men of the ordinary size of 150 pounds could easily do so. The result then would be 166.7 pounds per square foot.

The conclusion seems irresistible that loads of 180 pounds per square foot may actually occur in exceptional circumstances; that 160 must frequently occur; that 140 pounds must be common on station platforms, in corridors, and many other places frequented by throngs of people; and that 80 pounds per square foot must be common in social gatherings in private houses. The conclusion is equally clear that the margin of safety in many existing structures designed for 80 to 100 pounds per square foot, to say nothing of 40 to 45, must be much less than has been supposed.

NEW THEORIES CONCERNING RADIUM.

Theories recently put forward by Prof. Monroe Snyder, and Prof. Rutherford of McGill University, concerning the activities of radium, are of an exceedingly startling nature. Both gentlemen are, however, entitled to the utmost respect in everything that they have to say on the subject. Prof. Snyder, in a paper read before the American Philosophical Society, announced that he had discovered radium in the photosphere of the sun. In his opinion variable stars are caused not by the revolution of one body about another, but by the regular fluctuation of light due to periodical outburst of radial activity. He concludes that the sun is a variable star with a period of eleven years, and that the sun spots are one of the demonstrations of the emanations of radium. Other of the celestial phenomena, he thinks, are due to radium. Prof. Rutherford, while he does not leave the earth in his theories regarding radium, advances hypotheses no less startling. In an article in a recent number of *Harper's Magazine*, he speaks of the recent discovery that the radio-active bodies are able to emit an amount of heat about one million times greater than is evolved in the most violent chemical reaction. In the course of a year, one pound of radium would emit as much heat as could be obtained from the combustion of 100 pounds of the best coal, and at the end of that time the radium itself would be apparently unchanged and still giving out heat at the old rate. It can be calculated that this radium would on the average continue to emit heat at the above rate for about 1,000 years. The radium emanation stored in one gram of radium is about one cubic millimeter at atmospheric pressure and temperature. Assuming the molecular weight of this gas to be 100 times that of hydrogen, it can be calculated that one pound of the emanation, could it be collected, would initially radiate energy at the rate of about 8,000 H. P. The whole of the earth's crust undoubtedly is impregnated to some extent with radio-active matter. The amount of internal heat lost per second from the earth by conduction to its surface can readily be calculated. Since one gram of radium emits enough heat each hour to raise 100 grams of water through 1 degree C., the present loss of heat from the earth is equivalent to that which would be supplied by the presence of about 270,000,000 tons of radium. This amount, while large compared with the quantity of radium hitherto separated, is relatively small compared to the quantities mined of some other minerals, and if distributed uniformly throughout the earth's crust would correspond to only five parts in one hundred million per unit mass. Calculations made show that the radio-activity observed in soils corresponds to about this proportion of radium. If radio-active matter is distributed throughout the whole earth to the extent that experiment indicates, the heat evolved by the radio-active matter would compensate for the heat lost by the earth by conduction to its surface. According to this the present internal heat of the earth tends to be maintained by the constant evolution of heat by the radio-active matter contained in it.

STANDARD PRECISION SCREW.

In the daily consular report No. 2178, Mr. Walter C. Hamm, consul at Hull, England, refers to the need of a standard precision screw in the fine branches of engineering, and gives an interesting account of the method employed in the National Physical Laboratory at Bushy House, London, in the development of a standard screw. The British War Office four years ago appointed a committee of experts to investigate the subject and devise means for producing a screw of the utmost possible accuracy. The result of the labors of this committee is the new standard screw-cutting lathe which has recently been put in use, but of which no public test has yet been made.

"It became clear at an early stage of the investigation that to secure interchangeability in screws it was necessary to supply accurate standard leading screws from which the screws could be cut and to construct a special lathe on which these leading screws could be adjusted and measured. The standard screw now in Bushy House is made of compressed steel and is some 6 feet in length. The lathe to which it is attached exceeds 20 feet in length, and as it works to so fine a degree of accuracy as to correct an error of one ten-thousandth part of an inch, every precaution has been taken to protect it from the vagaries of temperature by housing it in a special building heated to a constant temperature of 60 degrees. The lathe differs in construction very greatly from ordinary lathes. The leading screw and the screw to be cut are coaxial. No gear wheels are employed, and there are means for automatically correcting even the most trifling errors of the leading screw.

"The lathe room, which is air-tight except for the ventilation afforded by inlets and outlets, is completely surrounded by an outer shell, and is provided with a glazed roof, while a glazed partition at one side enables observations to be made from the outside of the room. To prevent vibration, the lathe has been fixed on a foundation consisting of 20 tons of concrete covered with 6 inches of cork stone. The power is supplied by a 5 horse power motor, and arrangements are made for driving the lathe mandrel direct from the outside of the room. In this way the presence of anyone within the lathe room can be dispensed with for considerable periods at a time, and the machine with its automatic corrector can, under vigilant but unobtrusive supervision from without, be safely left to perform its allotted task with perfect fidelity and with such marvelous precision as almost to render the copy more perfect than the original.

For scientific purposes a screw must be so accurately cut and

its axis so true that it will move forward in its nut exactly the same distance for each rotation around its axis. It is said not to be difficult to produce a screw a foot or a yard long with errors not exceeding one one-thousandth part of an inch. Prof. William A. Rogers, of Harvard Observatory, invented a process by which a lathe tool while cutting a screw moved so correctly as to counteract the errors of the lathe. Machines have also been invented the errors of which, it is claimed, do not exceed one one-hundred-thousandth part of an inch at any one point. But the results have seldom been satisfactory. To secure the highest accuracy it has been necessary to resort to grinding."

METHOD OF SECURING INSERTED BLADES.

Zeitschrift fur Werkzeugmaschinen und Werkzeuge, October 5, 1904, p. 5.

There has been an effort for some time to substitute inserted tooth milling cutters for the solid and expensive head, and the variations in design have usually hinged upon the method of fastening the cutters. In Fig. 1 there is shown a cutter with spirally-arranged teeth, made of high-speed steel, with a

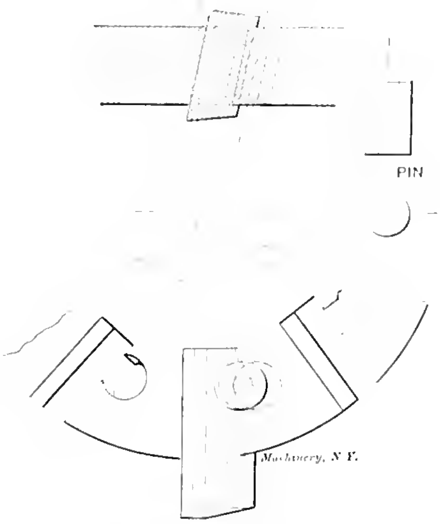


Fig. 1. Cutter with Spirally-arranged Inserted Teeth.

method of fastening that has proven reliable in service. A cylindrical pin somewhat larger in diameter than either of the circular openings is pushed into them by means of a simple contrivance. In order to increase the elasticity of the pin and with it the holding friction of the same, the latter is bored through from end to end. The steel is cut with a long groove that causes it to lip over on either side of the body of the holder. Even an imperceptible tightening or loosening is impossible in spite of the severest of shocks by which a screw fastening would be loosened. It is perfectly reliable and the parts are all interchangeable. When the steel is worn out it is removed from the head after pressing out the pin and another piece is put in in its stead. The cutters may have a diameter of 3 inches or more and a width of from 1/2 inch to 7/8 inch. The holder may be from 1/2 inch to 5/8 inch in thickness, or from 1/8 to 1/4 inch thinner than the cutter

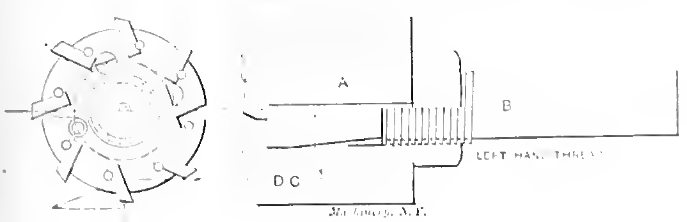


Fig. 2. Securing Inserted Blades in an End Mill

which lips over it on each side. A number of these heads may be used side by side, by allowing the cutters to interlock into each other, thus setting one just behind the other. By this means the breadth of the cut can be regulated.

For use on flat surfaces with an end miller the form shown in Fig. 2 is used. By turning the head A to the right on the shank B until it is finally tightened, the pressure pieces C will be forced against the surfaces of the steel cutters and thus these will also be fastened. The construction of the pressure parallelogram, shows that the division of pressure is very well equalized. The bolt B is cut with a left-handed thread, and the cutters, when at work, have a tendency to turn the head A about the shank B, so that the pressure piece C is continually forced against the cutters; this circumstance, in connection with the close-fitting round pin, makes any slipping or loosening of the steel impossible. Such a tool can be handled and treated in exactly the same way as though it were made of a single piece, and if the cutters are sharpened after they are put in position, their cutting action will be the same as that of a solid tool.

G. L. F.

CALCULATING CHARTS.

Abstract of article in The Mechanical World, Manchester, Eng., January 5, 1905.

The construction and use of charts in designing were fully set forth in the series of articles by J. S. Myers in MACHINERY for September to November. In this connection the charts given herewith may prove of value in expediting calculations on transmission. Fig. 1 is for the approximate determination of the width of belt to transmit a given horse power at any stipulated speed. The formula upon which the chart is based is:

$$W = \frac{33{,}000 \times \text{H. P.}}{\frac{T}{2} \times V}$$

Where W = width in inches.
T = working tension in belt.
V = velocity in feet per minute.

The three variable factors are H.P., $\frac{1}{T}$, and $\frac{1}{V}$. The above formula is based upon a coefficient of friction of .3 and an arc of contact of 135 degrees approximately, and takes no account

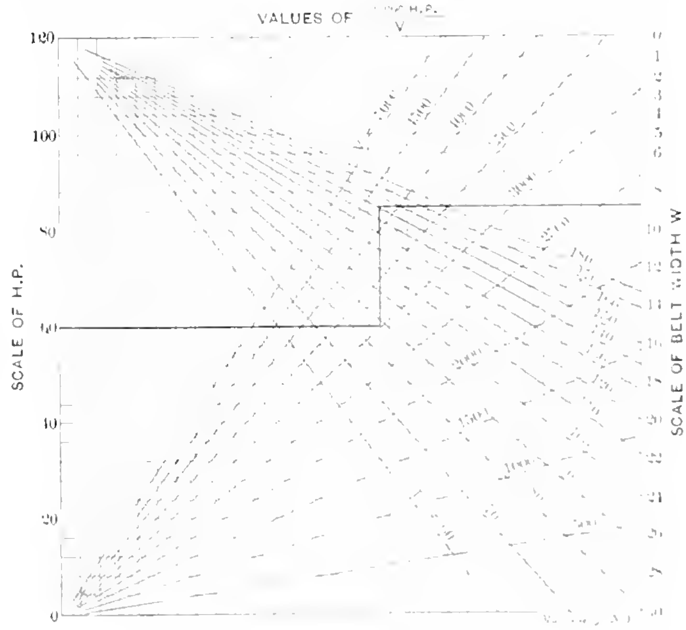


Fig. 1. Chart of Belt Widths and Horse Powers

of centrifugal action, which considerably reduces the effective belt tension at high velocities. We are only concerned with the constants in fixing the limits of the chart.

In plotting this chart, maximum and minimum values are taken as given in the accompanying table:

	H. P.	T	V	33,000 H. P. / T	[illegible] H. P. 2 / [illegible]
Maximum	100	180	5000	6600	220
Minimum	10	60	500	65	0.733

Horse power values are plotted to any suitable scale on the left of the diagram (in this figure carried to 120), values of the first product along the top line, and from the zero of the horse power scale sloping velocity lines to the correct points

on the upper line. On the right hand of the chart, downward, a scale of widths is plotted, reading to 30 inches. From the zero of the first product scale sloping lines are drawn downward to the correct points on the scale of widths, for the several belt tensions.

As an example of the use of this chart, let us find the width of belt necessary to transmit 60 horse power at a belt speed of 3,000 feet per minute, with an effective tension of belt of 150 pounds per inch of width. Enter the chart at 60 on the horse power scale, and move along the heavy line in the figure to the intersection of the 3,000 velocity line, thence vertically to the intersection of the 150 tension line, and on the scale of widths find the reqnired width of 9 inches. Obviously the process may be reversed, and given width, speed, and stress per inch width, we may find the horse power transmitted.

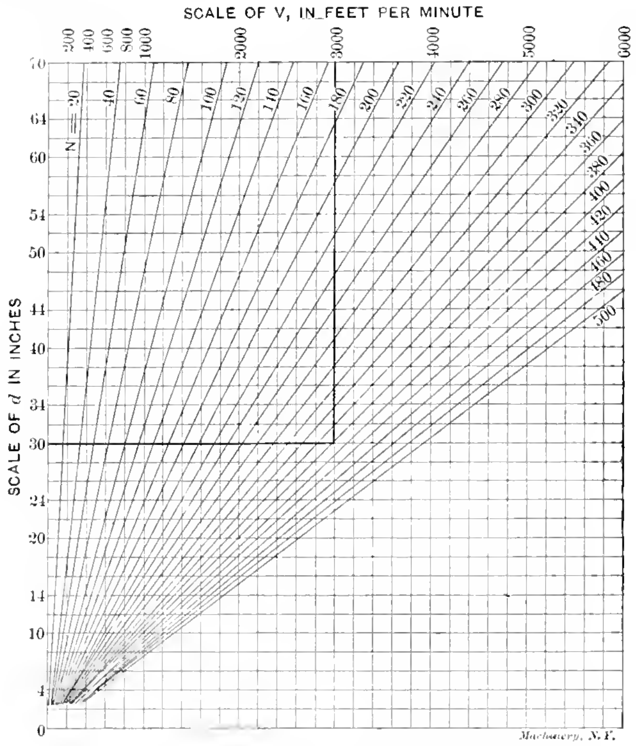


Fig. 2. Chart of Revolutions per Minute and Peripheral Velocity.

As the width varies directly as the horse power, it is obvious the chart is applicable to any values within a reasonable limit, as by multiplying or dividing any horse power on the chart by a multiple of ten, the corresponding width will be the width on the chart with the decimal point correspondingly shifted, and *vice versa.*

Fig. 2 is a chart expressing the relation between revolutions per minute, diameter of pulley in inches, and velocity of periphery in feet per minute, or $V = \frac{\pi d N}{12}$, where N represents revolutions. This chart is drawn to read a maximum of 6,000 feet per minute. Following the heavy line, we find that a pulley 30 inches in diameter, running at 380 revolutions per minute, has a peripheral speed of 3,000 feet per minute. This chart may well be used in connection with Fig. 1.

BENDING STRESSES IN WIRE ROPES.

From a Paper by Samuel Diescher read before the Engineers' Society of Western Pennsylvania, January 3, 1905.

According to the rule long since adopted in practice, sheave diameters shall equal or exceed forty-eight diameters of the corresponding ropes; that is to say, that for every ¼ inch of the diameter of the rope, 12 inches are to be allowed for the diameter of the sheave. That this ratio is adequate has been amply proved, and the advantages of using a sheave of this diameter over a smaller one are numerous. In what is to follow, this ratio will be assumed.

A formula for the calculation of bending stresses in wire rope is given in Kent. Tables containing the results of calculations for various sizes of ropes and sheaves are also given, but no cognizance is taken of the load hanging on such a rope in that formula, whereas, as a matter of fact, more effort is required to bend a rope if taut than if slack. This formula was apparently made under the impression that in bending a rope conditions are about the same as if bending a solid bar, but such is not the case. In the bending of a rope about a sheave a compensation between the strands may be shown to occur, by which the increase in the outer circumference over that of the neutral axis of the rope is supplied by a corresponding decrease in the inner circumference, without any part of the strand being severely stressed. This compensation occurs locally within every turn of the strand. The tendency to pull in the upper part of the bend is equal to that to shove in the lower part, and as both these forces lie in the same line and act in the same direction, they act in accord. Hence the movement within the strands would meet with no resistance but for the fact that the strands are in close contact with each other and the rope is in tension, due to the work it performs; hence a certain amount of friction must be overcome when the strands adjust themselves to altered conditions.

Considering a 2-inch rope and a sheave of 8 feet diameter, the outer circumference of the rope is approximately 1 foot greater than that of the sheave. The rope measured along its neutral axis is approximately one-half foot longer than the circumference of the sheave, hence the elongation that occurs on the convex side of the rope during one revolution is ½ foot, and the contraction on the concave side of the rope is also ½ foot, and this difference must be adjusted when the rope changes from a straight line to a circle by the excess of the concave side shifting to the convex side. This motion is the aggregate of all motions in one strand that occur during a full revolution, and must take place under the pressure the rope exerts against the rim of the sheave, which in turn reacts upon the rope and its strand. The resistance that opposes this motion is friction among the strands as they rub against each other.

The intensity of this friction depends upon the pressure applied, and the coefficient of friction of the materials in contact, which to be quite safe will be assumed to be 0.15. The pressure that the rope exerts upon the circumference of a cylinder of any diameter is $2 \times 3.14\,P$ per full coil, in which P represents tension in the rope due to its load. If we assume that tension, for example, at 30,000 pounds, one coil exerts upon the circumference of a sheave $2 \times 3.14 \times 30{,}000 = 188{,}400$ pounds. The circumference of an 8-foot sheave being 25 feet, the pressure upon one foot of this circumference is approximately 7,200 pounds. In a rope of 2 inches diameter a strand makes one winding turn around the core in 12 inches, in which length the compensation between compressed and pulled parts of that strand must also take place, and as this compensation is continuously occurring, and exactly 12 inches of that rope are always affected, it is evident that the resistance opposing that readjustment is the friction produced by the pressure upon 12 inches of that circumference of the sheave. Hence the friction thus produced is $7{,}200 \times 0.15 = 1{,}080$ pounds, and as there are six strands in the rope at all times engaged in the act of adjustment, the total bending stress in the rope will be $6 \times 1{,}080 = 6{,}480$ pounds.

The work done in this bending is the bending stress multiplied by the amount of motion in the strands during the process of adjustment in one revolution. As the whole movement of the strands within one coil of the rope on the sheave is ½ foot, the work of bending is $\frac{1}{2} \times 6{,}480 = 3{,}240$ foot-pounds.

Applied to a practical case, say a shaft of 1,000 feet depth, the same sheave will make $1000/25 = 40$ revolutions, and therefore the work done during one run in bending the rope is $40 \times 3{,}240 = 129{,}600$ foot-pounds. If this run is made in one minute the power consumed is 129,600/33,000 equals approximately 4 H. P., or if made in two minutes 2 H. P.

If, however, we want to use a sheave of only 4 feet diameter, the total pressure the rope would exert upon the rim of the sheave is independent of the diameter, but as the circumference of the sheave is only one-half as much as for the 8-foot sheave, the pressure per lineal foot of rope is twice as great and consequently the friction opposing the adjustment of the strands is double that in the case of the larger sheave. This is sufficient reason for the selection of large diameters for sheaves,

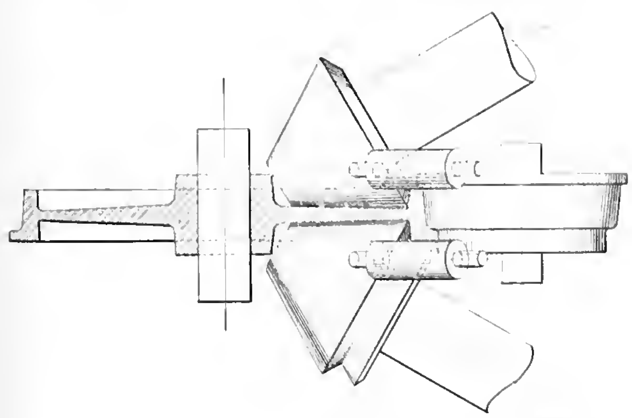
but also it must be considered that with a 4-foot sheave the compensating motion of a strand in a given length of rope is twice as great for the same length of rope as with the 8-foot sheave, so that the energy consumed in bending is four times that required with an 8-foot sheave. In short, the resistance opposing the adjustment of the strands grows inversely with the square of the diameter of the sheave, the velocity being the same in both cases. The straightening of the rope on leaving the sheave does not require any external force, because in the act of bending the elastic resistance of the sheaves must be overcome, whereby energy is stored in those strands, just as in compressing or stretching a spring which resumes its original state on being released. There is, of course, a limit to the compensating capacity of the strands in a rope, but this limit can only be determined by actual trials under working conditions. This task by right falls upon the manufacturers of wire rope.

ROLLED STEEL CAR WHEELS.

Abstract of Article by Samuel Vauclain, Superintendent Baldwin Locomotive Works, in the Journal of the Franklin Institute, February, 1905.

The requirements for car wheels have risen very rapidly during the last few years, the loads upon them having increased from fifty to a hundred per cent, whereas it has been impossible to increase the weight of the wheel in like proportion. The chilled cast iron wheels have been very successful in meeting the demands upon them, but the brittleness of the flange, inability to resist the heating effects of the brake shoe, internal stresses induced in the casting, etc., of this type have created a field for a wheel free from these objections. Steel tired wheels have been made, having centers of cast iron, cast steel and wrought iron and of both plate and spoke form. Even these wheels suffer from shelly spots on the tires unless great care and expense attend their manufacture.

A solid forged high-carbon rolled-steel wheel, to be successful, must be cheap enough to compete with the cast chilled wheels, and good enough to compete with the high-priced steel-tired wheels. The process of its manufacture is simple. An ingot is cut into sections, each of which is of sufficient weight to make a wheel, the upper or segregated section of the ingot being discarded. Each of these sections is then pressed into shape under a 5,000-ton hydraulic press, the blanks being handled by mechanical means. The blank is transferred from there by overhead cranes to the rolls, where it is subjected to enormous pressure, and revolved at a high rate of speed, emerging a perfect wheel. The method of rolling and the arrangement of the rolls is shown in the diagram. If the plate of these wheels is to be of the dished or curved form, the wheel is placed in the 5,000-ton press, and gently squeezed into shape.



Arrangement of Rolls for Rolling Steel Car Wheels

The quality of the wheel is attested by examination of etched sections, and favorable judgment is confirmed by the results of the physical and chemical tests, the latter being very uniform, indicating the greatest uniformity in the wheel. Various severe impact and other physical tests have been successfully withstood by this type of wheel. One of the most severe tests that can be imposed upon the chilled iron wheels is the thermal test, which consists in pouring a ring of molten iron, 1½ inches thick and 4 inches deep, against the tread, no cracks to develop within two minutes. This test is to take account of the heat developed by the application of the brake shoe. A number of rolled wheels have been subjected to this test without injury to them.

As to the value of these wheels compared with cast chilled wheels of the best material and manufacture, the following statement has been prepared, comparing the cost of the two types per 10,000 miles:

SOLID ROLLED WHEELS

Cost of pair of rolled wheels	$54.00
Cost of four turnings	2.40
Cost of four removals and applications	2.40
	$58.80
less scrap value	8.75
Net cost	50.05

Mileage, 350,000.

Cost per 10,000 wheel miles, $1.43.

CHILLED-IRON WHEELS.

First cost of pair of chilled-iron wheels	$18.00
Cost of boring and mounting	80
Cost of removal and application	60
	$19.40
less scrap value	5.80
Net cost	$13 60

Mileage, 80,000.

Cost per 10,000 wheel miles, $1.70.

The natural field for the rolled wheel is: (1) The severe service of engine and tender trucks, in which steel tired wheels are now exclusively used; (2) passenger car equipment, in which the element of safety is very important; (3) heavy freight car equipment, for which the chilled iron wheel has proved inadequate. The wheels, however, are adaptable for lighter service, and could be profitably employed in street car service.

MULTIPLE-EFFECT EVAPORATION.

Abstract of a Paper read before the Manchester Eng. Association of Engineers, January, 1905.

The basic principle of multiple-effect evaporation, by which the effect of one pound of steam may be multiplied three or four fold in evaporating juices or liquids, may be illustrated by Fig. 1. Ordinary multiple-effect evaporators consist of two or more vertical cylindrical vessels somewhat like surface con-

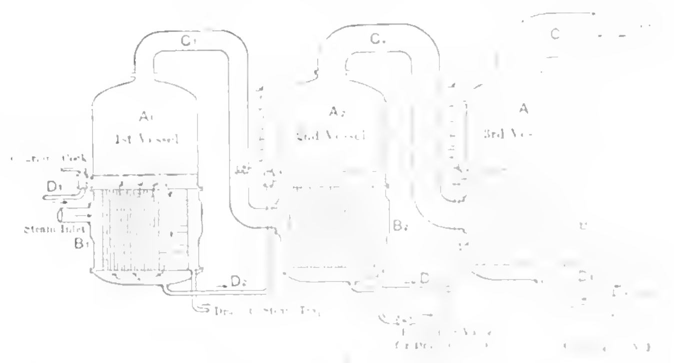


Fig. 1. Triple-effect Evaporator

densers in character. Steam, either as the exhaust from the engines or direct from the boilers, is usually the source of heat by which the evaporation is brought about. The steam thus supplied is taken to the first of the vessels, where it surrounds tubes containing the liquor to be evaporated. The pressure inside the tubes is kept lower than the pressure of the steam supplied to the casing round the tubes, hence the boiling temperature of the liquor inside the tubes is lower than the temperature of the saturated steam outside, with the result that the steam will be condensed to water, which, however, will still be at a higher temperature than the liquor and vapor in the tubes. The heat thus given up will practically be the latent heat of the steam, and each pound of steam condensed will evaporate approximately one pound of the water in the tubes, thus generating steam in the tubes. This steam is then conveyed to the shell of the second vessel, which also contains tubes through which the liquor to be evaporated passes.

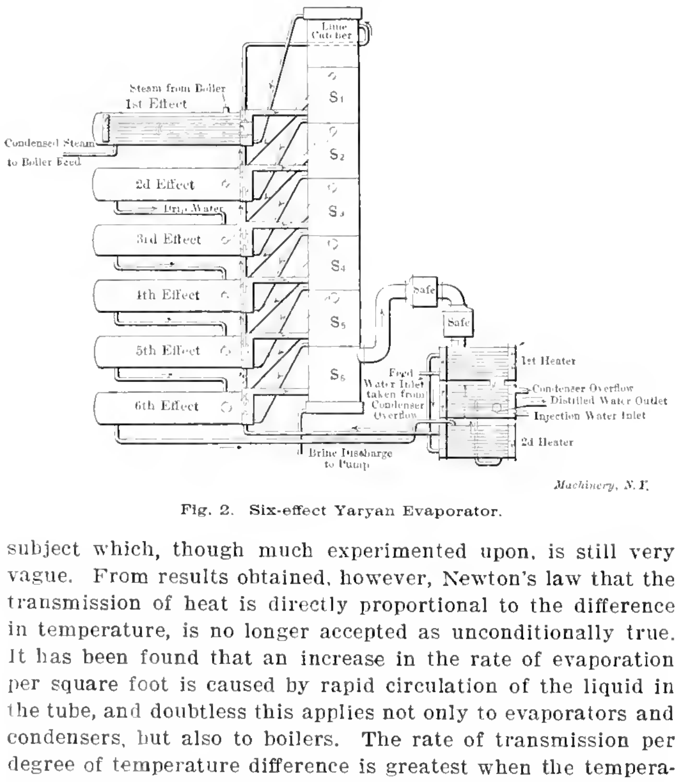
The pressures in the casing and tubes of the second vessel are lower than in the casing and tubes, respectively, of the first

vessel, hence the steam generated in the tubes of the first vessel now surrounds tubes containing liquor at a lower temperature than its own. It is therefore condensed, and in condensing evaporates approximately another pound of water. This system can be carried on to any number of effects allowed by the temperature limits.

In Fig. 1, a diagrammatic arrangement of a triple-effect evaporator, the steam enters the shell of the first vessel, as shown, and the liquor to be evaporated enters the tubes of the first vessel through pipe D_1, usually hot. The course of the operation is then as outlined above.

As the pressure in each succeeding vessel into which the liquor to be evaporated passes is lower than in the preceding one, no pump is required beyond that necessary to force it into the first vessel, a regulating cock, however, being placed between each vessel for the regulation of pressure, etc. The pressure in the last vessel is almost always below the atmosphere. In dealing with the concentration of certain liquors, it is desirable that the highest density should be accompanied by the highest temperature, as owing to the increased fluidity at higher temperatures, the concentration can then sometimes be carried to a greater degree. In this case the liquid, instead of entering the first vessel and finishing at the third, may have its passage through the machines reversed, in which case pumps are necessary to convey it from vessel to vessel owing to the pressure rising in the direction of the flow instead of falling.

In the design of such evaporators an important point is the rate of heat transmission from metallic surfaces. This is a subject which, though much experimented upon, is still very vague. From results obtained, however, Newton's law that the transmission of heat is directly proportional to the difference in temperature, is no longer accepted as unconditionally true. It has been found that an increase in the rate of evaporation per square foot is caused by rapid circulation of the liquid in the tube, and doubtless this applies not only to evaporators and condensers, but also to boilers. The rate of transmission per degree of temperature difference is greatest when the temperature differences range from 15 degrees F. with a low speed of flow, to 40 degrees when the speed of flow is 5.4 feet per second. The rate of transmission also is three to four times as high when heat is transmitted to a boiling liquid than to one not boiling.



Machinery, N.Y.

Fig. 2. Six-effect Yaryan Evaporator.

Fig. 2 represents diagrammatically a six-effect Yaryan evaporator. When used for the distillation of water the impure water is drawn from the circulating water which has passed through the condenser, and has thus become somewhat hot. It is then pumped through the first heater, then forward through the second heater, whence it passes through heater tubes shown dotted on the diagram.

By the time it has passed through the last set of heating tubes contained in the first or high temperature effect, its temperature will not be much below the temperature of the steam supplied to that effect. At this point it may be taken to a specially constructed lime catcher, shown on top of the separator column, where by the use of a steam coil and suitable reagents, most of the lime and similar salts are precipitated. Here, also, the water is filtered; it then passes to the evaporating tubes of the first effect. The shell of this vessel or effect receives steam from the boiler at a pressure of about 40 pounds per square inch. In many cases a higher pressure and a greater number of effects may be adopted where the liquor is such that treatment at a high temperature is not likely to be injurious, but machines are seldom made with more than six effects.

The water formed by the condensation of steam supplied to the first effect is usually returned direct to the boiler, which is thus fed with pure distilled water at a high temperature; consequently a high evaporation per pound of coal should result. The steam formed in the tubes of the first effect, together with the water, pass to the separator, S_1, where the steam separates from the water and is led to the shell of the second effect, while the water passes into the tubes of this effect. The pressure in the shell of this effect practically corresponds with the pressure in the tubes of the first effect, but the pressure in the tubes of the second effect is several pounds lower; hence, as the water entering the tubes is at the higher temperature of the previous effect, there is immediate and spontaneous evaporation of some of the water, which causes a lowering of the temperature of the remainder. This reduction of temperature permits of heat being transmitted through the tubes from the steam on the other side, causing evaporation of a further quantity of water, and the condensation of the steam outside of the tubes.

Again the mixed water and steam pass to the separator, S_2, and the separated steam is then led to the shell of the next effect, and the water to its tubes; but as the water produced by the condensation of the steam supplied to the shell of the second effect is not wanted for boiler feeding, it is drained into the shell of the third effect, as shown, and there imparts some of its heat to the water in the tubes. Spontaneous evaporation also takes place here, owing to the water entering a vessel in which the boiling temperature of water is lower than the temperature of the incoming water.

This cycle of operations is repeated in succeeding effects until the last one is reached, which in the example chosen is the sixth effect. From here the water drained from the second, third, fourth, and fifth effects, together with the water of condensation formed on its own tubes, is drained to the second heater, whence it passes to the condenser. The steam from the last separator, S_6, passes through the safes to the first heater, where some of it is condensed, the final condensation taking place in the surface condenser shown, where not only does this condensation take place, but the water so formed is, along with the water drawn from the previous shells, finally cooled by the circulating water in condenser.

It is evidently important that great care be taken in the design to see that no water is carried over with the steam, otherwise the purity of the distilled water produced would be vitiated. Results of tests made upon Yaryan six-effect machines have shown as high as 44 pounds of water evaporated and condensed per pound of fuel consumed.

THE STRENGTH OF COLUMNS.

Abstract of Paper by Professor W. E. Lilly, Trinity College, Dublin, before the Institution of Mechanical Engineers, February 17, 1905.

The formulas in general use for the design of a column of a given length to carry a given load do not take into consideration the ratio to be adopted between the area and radius of gyration of the cross section of the column which are involved in its design, it being left to the designer to assume empirically such values as seem most suitable. Theoretically there is for every column of given length and load a definite area and radius of gyration for the most economical cross section; for instance, in the case of a hollow mild steel column of circular cross section, the column fails by wrinkling of the sides of the column, or by secondary flexure, if the diameter is large and the thickness small; if the diameter is small and the thickness great, it fails by primary flexure or bending. The author of this paper made about eight hundred tests on hollow tubes, stressed as columns would be, with the view of determining the conditions under which failure occurs, and to obtain definite information as to the values of the areas and the radii of gyration of the best cross sections.

The tubes tested were of mild steel, and as nearly as possible of uniform quality. Tests were carried on in a 10-ton Wicksteed testing machine of the vertical type. The investigation was limited to round-ended columns, owing to the small size of the machine.

The results of the tests were averaged and curves plotted showing the relation between the breaking load and the length divided by the radius of gyration. From these curves the curves here given, as Figs. 1 and 2, were prepared. In Fig. 1 the influence of the thickness in determining the load which produces failure is shown, the curves A to F being deduced from the curves just referred to, the diameter and thickness of the tube being varied and the area of the cross section kept constant, the uppermost curve of the series being for the limiting case when the tube becomes a solid bar. The curves shown in Fig. 2 were obtained by plotting the curves of Fig. 1 to a base line representing length, and ordinates representing breaking load. From these curves it will be seen that the economical ratio of the diameter and thickness for a given cross section depends upon the length of the column. The breaking strength of tension of these tests averaged nearly 72,000 pounds per square inch, and the average of the breaking strength for compression was 80,000 pounds per square inch, which was used throughout in plotting the curves given. Experiments also made determine the coefficient of elasticity as having an average value of thirty million pounds per square inch, which value was used in plotting the curves.

for wrought iron = 36,000 pounds; A = area of the cross section, $c = \frac{1}{3000}$ for columns with round ends, = [illegible] for columns with fixed ends; l = length of column, ρ = radius of gyration of the cross section.

This formula gives approximately the breaking load for both short and long columns, the value of f and c being determined by experiments. It does, however, take no account of the ratio ρ/t, nor does it point out the most economical values of l/ρ to be used.

In the diagram Fig. 1, the breaking load for the tubes calculated from Euler's formula is shown. For values of l/ρ greater than 120 for the solid bar to values of l/ρ greater than 240 for the thinnest tubing, the failure is sensibly elastic, and the experiment is in accord with the values as calculated.

The curves shown in Fig. 1, drawn to refer to tubes of constant cross section, were deduced from the curves of individual tests in the following manner; the Rankine-Gordon formula was used in the form:

$$p = \frac{P}{A} = \frac{f}{1 + \frac{1}{9000}\left(\frac{l}{\rho}\right)^2}$$

suitable values being given to f.

It was found that the strength depended in some way on the ratio ρ/t, since the breaking load was less when the diameter was varied and the thickness constant, and greater when

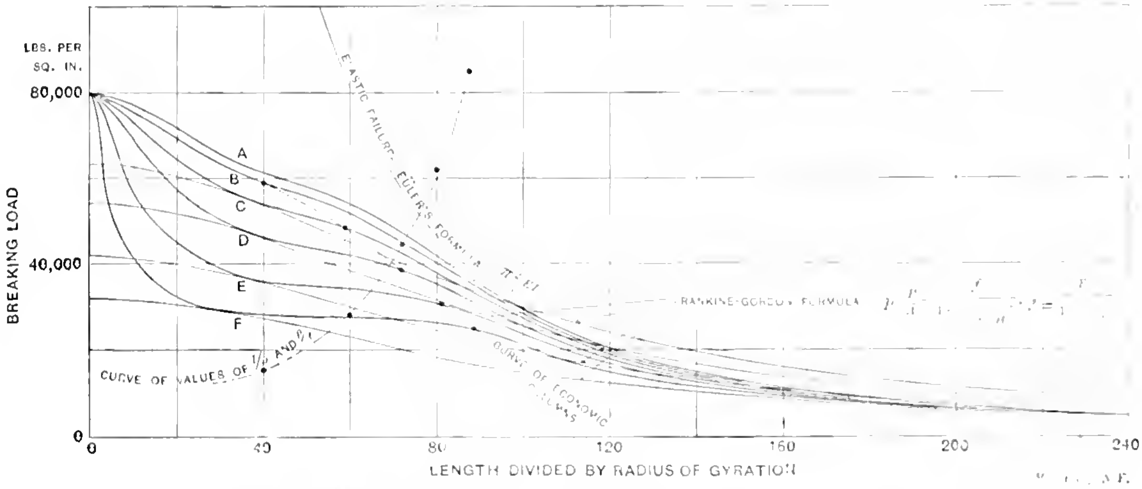


Fig. 1. The Relations between the Breaking Load and the Length Divided by Radius of Gyration of Columns

The following phenomena were observed throughout the tests: that for all columns there was a certain value of l/ρ in which l is the length and ρ the radius of gyration, beyond which the failure was sensibly due to elastic bending, the load producing failure varying inversely as the square of the length, and that as the value of ρ/t, where t represents the thickness of the tube, increased, the value of l/ρ increased for the load producing failure by elastic bending. It was also remarked that when failure of the column took place by secondary flexure for a large range of the length, there was little variation in the breaking load, and also that as the load approached the breaking load, there was on the short lengths a distinct yielding of the tubes before failure.

The formulas in most general use for the design of columns are Euler's and the Rankine-Gordon formula. Euler's formula is $P = \pi^2 \frac{EI}{l^2}$, where P equals the load on the column, E the coefficient of elasticity, I the moment of inertia of the cross section, and l the length of the column. This formula is only applicable to columns which fail by elastic bending, that is, long columns. For practical columns with the usual ratio of l/ρ, it fails to give the breaking load. It applies quite accurately to long columns, the influence of the ratio ρ/t causing but little variation in the strength.

The Rankine-Gordon formula is $P = \frac{fA}{1 + c\left(\frac{l}{\rho}\right)^2}$, where f = about two-thirds the compressive strength of the material,

the thickness varied and the mean diameter was constant. By plotting values, the following formula was obtained:

$$f = \frac{F}{1 + k\left(\frac{\rho}{t}\right)^2}$$

where F = the compressive strength of the material, and k = a constant for mild steel = 1/60.

For the solid bar the value of f is sensibly equal to F. This formula closely gives the required values and appears to be of the correct form. Substituting for f in the Rankine-Gordon formula, the latter now takes the form:

$$p = \frac{P}{A} = \frac{F}{\left[1 + k\left(\frac{\rho}{t}\right)^2\right]\left[1 + c\left(\frac{l}{\rho}\right)^2\right]}$$

putting $k = \frac{1}{60}$ and $c = \frac{1}{9000}$ for columns with round ends.

$$p = \frac{P}{A} = \frac{F}{\left[1 + \frac{1}{60}\left(\frac{\rho}{t}\right)^2\right]\left[1 + \frac{1}{9000}\left(\frac{l}{\rho}\right)^2\right]}$$

This formula was used to determine the curves shown in Fig. 1, the value of F used being 72,000 pounds per square inch. The remaining curves showing the actual failure of the columns were plotted from the curves averaging individual tests, before alluded to, and refer to tubes of a constant cross section of 0.12 square inches, of the sizes given in Table 1.

TABLE I. DIMENSIONS OF TUBES OF CONSTANT CROSS SECTION.

External Diameter. Inch.	Internal Diameter. Inch.	t	ρ	Reference to Curves.
1	0.92	0.04	0.34	F
0.875	0.78	0.048	0.3	E
0.75	0.636	0.057	0.25	D
0.625	0.481	0.072	0.2	C
0.5	0.3	0.1	0.15	B
0.4	0	0.2	0.1	A

The diagram Fig. 1 thus obtained may be used for mild steel columns with round ends having the same ratios l/ρ and ρ/t.

The formula takes into consideration both the primary and secondary flexure of the column. The latter will be of maximum strength when the strength for primary flexure is equal to that of secondary flexure. The diagrams show the variation of ρ/t, with the length for a constant cross section. This ratio will now be put in a simple form so as to be of practical use.

In Fig. 1 the economical values of l/ρ were plotted from the curves in Fig. 2, giving the dotted curve as shown; this may be considered as approximately a parabola having the equation:

$$\left(\frac{l}{\rho}\right)^2 = 1000\left(\frac{\rho}{t} - 0.5\right)$$

For practical values of l/ρ the term 0.5 can be omitted, giving the simplified form $\rho^3 = 1\text{-}1000\ l^2 t$. (1.) This equation applies to the column of hollow circular cross section; for columns of other cross section the constant 1-1000 requires to be slightly modified.

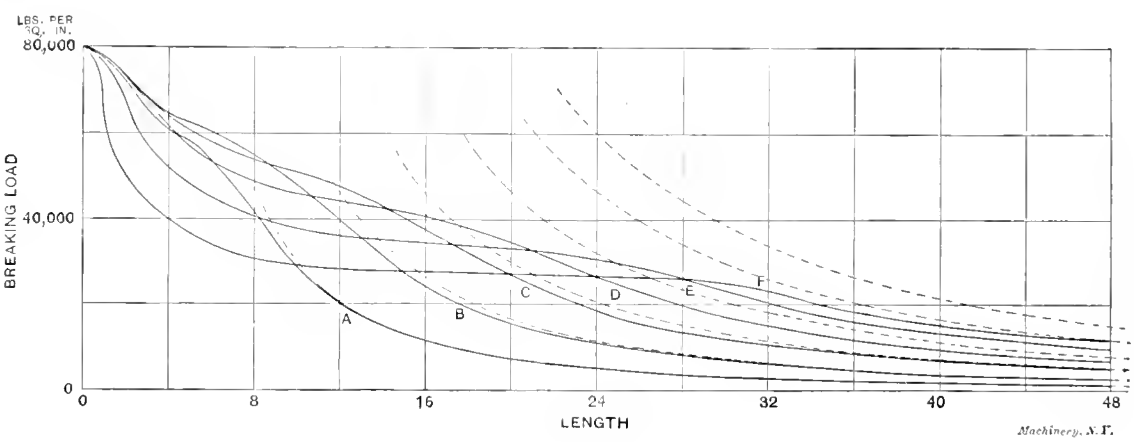


Fig. 2. The Curves of Fig. 1 Plotted to a Base Line Representing Length.

If A is the area of the cross section and d the mean diameter of the column, $\pi\, d\, t = A$ approximately. Also $\rho = \frac{d}{\sqrt{8}}$; hence $t = \frac{A}{8.9\,\rho}$ approximately. Substituting in the previous equation—

$$\rho^2 = \frac{\sqrt{A}}{94}\, l$$

for hollow circular columns and for other cross sections

$$\rho^2 = \frac{\sqrt{A}\, l}{h} \qquad (2)$$

h being a constant depending on the value ρ/t of the cross section required.

This equation shows that ρ varies as $\sqrt{l}$ if the area of the cross section is constant. Now A represents the area of the cross section, and is supposed to be known; to determine it, values of p and l/ρ for the economic section were plotted, giving the curve as shown in Fig. 1, the equation of which is approximately—

$$p = \frac{P}{A} = \frac{F}{1 + \frac{1}{3500}\left(\frac{l}{\rho}\right)^2} \qquad (3)$$

The equation resulting from substituting F or A from equation (2) is difficult of solution; hence proceeding tentatively, and assuming a probable value of l/ρ for the column, usually about sixty to ninety for the ordinary run of columns, and solving equation (3) the value obtained is

$$A = 2 \text{ to } 3\,\frac{P}{F}$$

where P is the load on the column and F the ultimate compressive strength; this must be divided by the factor of safety for the practical column, giving

$$A = 2 \text{ to } 3\left(\frac{PS}{F}\right)$$

where S = the factor of safety.

Substituting for A in equation (2) the economic values of ρ can be easily determined. Checking up the dimensions of the column thus ascertained by the general formula, we find that the safe load, P, will in general be greater for actual practice than is given in the formula, an error on the side of safety.

There has been considerable diversity of opinion as to the value of the constants that should be used in the Rankine-Gordon formula, owing to the incompleteness of the experimental work hitherto carried out. For the ordinary ratios of ρ/t in practice, the Rankine-Gordon formula gives fair results, but it does not apply with the same accuracy to solid bars or columns in which the ratio of ρ/t is large; it is quite far from the truth for values of l/ρ at which failure takes place by elastic bending. As Euler's formula is sensibly true for long struts the author proposes a modification of the latter for this case, which, however, involves the use of several constants, for which further experimental data are needed before its adoption.

HARD-DRAWN COPPER WIRE.

In a paper—"Telephone Line Engineering"—read by Mr. C. J. H. Woodbury before the January 12th meeting of the Franklin Institute, allusion was made to the important improvement made in copper wire for aerial lines by Thomas B. Doolittle. Although it was early recognized that copper wire was much better suited to the needs of telephony than iron wire, its use was impracticable because of the soft, ductile nature and low tensile strength of commercial wire. When suspended between poles it would continue to stretch until it became so attenuated that it would break of its own weight, or touch the ground and thus interrupt the circuit. Doolittle's great improvement consisted essentially in omitting the annealing processes during the latter part of the drawing, and attenuating the wire by smaller gradations of the die-plates. In this manner the copper wire was made with a dense hard surface, causing it to receive the appellation of "hard-drawn." The increase of strength is naturally greater in the smaller diameters since the treatment affects the thin surface layers most. For instance, a hard-drawn No. 8 copper wire is 0.165 inch diameter and has a tensile strength of 62,100 pounds per square inch of cross-section, while No. 12 wire, 0.104 inch diameter, has a tensile strength of 64,600 pounds. It will be seen that the strength is nearly doubled since commercial copper wire has a tensile strength of only about 32,000 pounds. The modulus of elasticity is increased from 12,000,000 to 19,000,000 pounds and the elongation before rupture is reduced from 35 per cent to 1¼ per cent. This remarkable change is effected entirely by manipulation and without the addition of any alloy.

THE MAKING OF FINE TOOLMAKERS' FILES BY AMERICAN METHODS.

An interesting industry has been established at Elizabethport, N. J., which is an example of the application of American methods to the manufacture of products that have heretofore been mainly produced in the Old World by slower hand processes. This industry is that of the American Swiss File & Tool Co., which began operations in its present factory in 1900. Its founder is Mr. Edward P. Reichhelm, mechanical engineer, and president of the American Gas Furnace Co., New York City.

The manufacture of the larger, heavier and coarser grades of files commonly used by machinists has always been an important industry in America, and their production of these has been so successful that they have not only supplied the demand of the home market but have competed successfully in Europe with those made by foreign companies. The finer grades, however, used by toolmakers, diesinkers, jewelers, watchmakers, and others, have always been imported from Switzerland in large quantities. The file-making industry in Switzerland has developed as a necessary adjunct of the watch industry in that country, and the Swiss files in the finer grades have reached a high degree of perfection. In the manufacture of Swiss watches the parts have been and are still largely shaped by hand and as the file is the tool most used in this work it is natural that attention should have been given to the production of small files to meet the home demand. This condition is responsible for the success of the files made in Switzerland.

Fig. 2. A Corner of the Forge Shop.

Mr. Reichhelm, who has given his personal attention to the development of the industry at Elizabethport, has long been of the opinion, as the result of his experience in the use of gas furnaces for hardening and annealing steel, that it would be possible to produce the best results in file manufacture by methods somewhat in advance—from a commercial standpoint—of those employed in Switzerland. The American Gas Furnace Co. manufacture oil-gas machines and furnaces of many descriptions, and in the installation and operation of the many plants which they have designed a fund of information has been acquired in regard to the treatment of steel that is well-nigh invaluable in the manufacture of a product like files, in which absolute uniformity of results is desirable.

The American Swiss File & Tool Co. occupies a small but new and well-equipped factory, and there is land for such extensions of the plant as may be required. As the process of file-making is not understood by many it will be of interest to follow through the different steps and refer to features of the process which have made this company successful in their venture. While the steps of manufacture taken by themselves appear to be extremely simple and are no different from what may be found in other lines of work, the development of the process as a whole has not been by any means an easy matter. In fact so many technical difficulties were encountered that at the end of a year and a half the investment actually required footed up to four times the amount included in the first "liberal estimate" made. While the original conception of the methods of production proved to be correct it required much patient labor to put them into practice with a working force which had to be newly created.

A view of the new plant is given herewith. It is a one-story brick structure, lighted both by side and roof windows. In developing the process of file manufacture attention was first given to the heat treatment of the steel. It is necessary, first, that the stock should be annealed in a way that will not injure the steel and that will produce steel of uniform hardness, not only in each individual file, but in all the files of the successive lots which are in progress through the works. By securing, first of all, this uniform quality in the file blanks it is possible to cut the teeth in a satisfactory manner and if equal attention is given to the shaping of the blanks and to the hardening, straightening and cleaning of the finished product the most essential points will have been provided for.

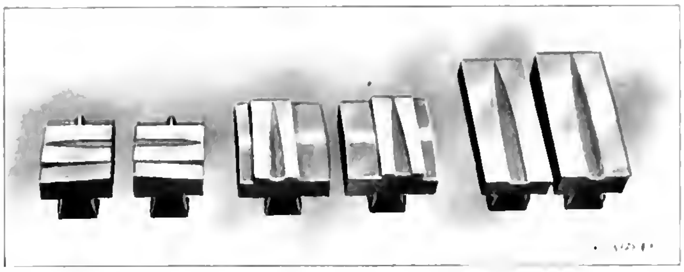


Fig. 3 Three Sets of Dies for Forging the Blanks

The main innovation in the manufacture of these files is the use of the gas apparatus previously referred to, by which the same accurate results are obtained in the quality of file blanks as are secured in plants manufacturing milling cutters and other tools requiring careful annealing and hardening. In this system a gas-generating plant is employed by which gas is produced from naphtha. Naphtha is utilized as being the best adapted to this purpose of any of the petroleum products. It is a refined product freed from all substances that cannot be atomized by moderate force or vaporized under a temperature below 80 degrees F. It may be completely converted into gas with no residue, and by suitable apparatus it is possible to secure a permanent gas of high calorific power which will have no tendency to condense in the apparatus where it is employed. Another advantage of naphtha over crude petroleum products is that it is freed of all trace of sulphur or other elements that can in any way injure the quality of the steel. In annealing with naphtha gas it is not necessary to pack the articles to be treated in a cast-iron box since the direct heat of the furnace, if kept at the proper temperature, can in no way harm the steel.

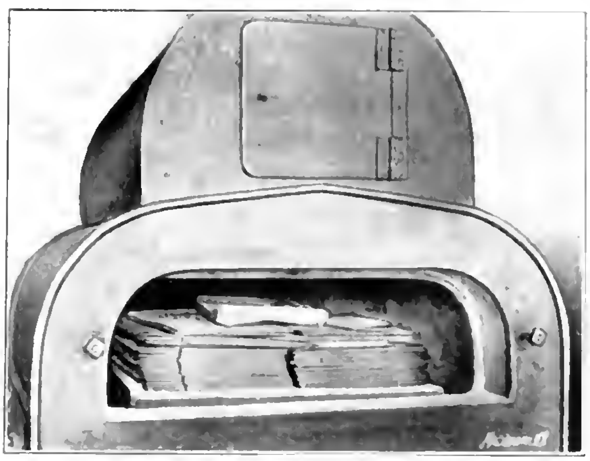


Fig. 4 Blanks in a Gas Furnace ready for Annealing

The process of producing naphtha gas is carried on in an

apparatus in which the main element is a large metal tank or generator made up in three sections. In the bottom section is the naphtha, which is forced into the middle section where it mixes, in the form of a spray, with a stream of heated air. The air and naphtha then pass to the third section where they are forced through several screens, causing a minute subdivision of the naphtha spray and a close intermingling of the air and naphtha. The naphtha is so finely subdivided that it produces a permanent gas, and if at this point any particles are not sufficiently subdivided to mingle with the air they drop to the bottom of the chamber, where they are drawn off and return to the tank. At one point in the process the air is allowed to drop sufficiently in temperature to cause a condensation of whatever water-vapor it may contain. This assists in the commingling of the air and naphtha-vapor. The gas is finally heated by passing through coils subjected to steam heat before it is used, and it is employed in the furnace in Machlet burners, where it burns in contact with an air blast supplied by a positive-pressure blower.

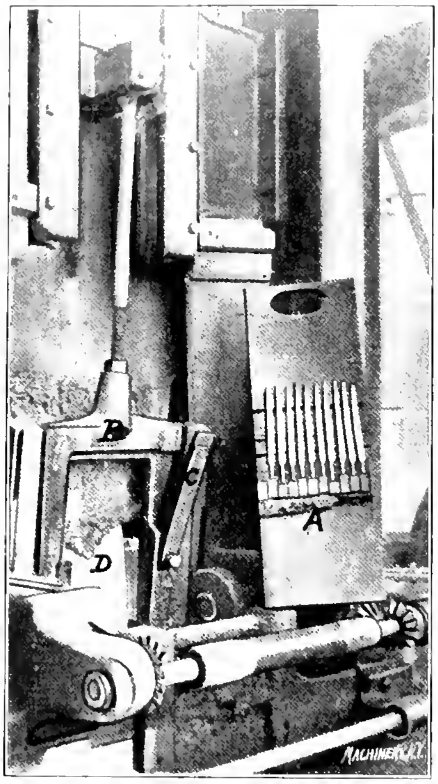


Fig. 5. Machine for Grinding Blanks.

The forging of the blanks is done mainly under Bradley hammers, one of which, with the gas forge, is shown in Fig. 2. The method of working with these hammers is familiar to most of the readers of MACHINERY. The facility with which the blanks can be shaped depends upon the dies employed, three pairs of which are shown in Fig. 3. The face of each die is made in three sections, as shown in the two left-hand pairs of dies in Fig. 3. The section on one side of the die is used in breaking down the edge of the stock, that on the other side for bringing the edge of the stock to approximately the right dimensions, and the central portion is employed in forming the flat sides or faces of the blanks. The pair of dies at the left is for forging the blanks for warding files; the pair at the center for half-round files, and the pair at the right is used in a drop-hammer only, for the purpose of finishing the blanks of half-round files. Special shapes, like half-round files, Barrette files, etc., are finished by drop forging, while the ordinary shapes are finished under Bradley hammers.

Fig. 6. Cutting by Hand

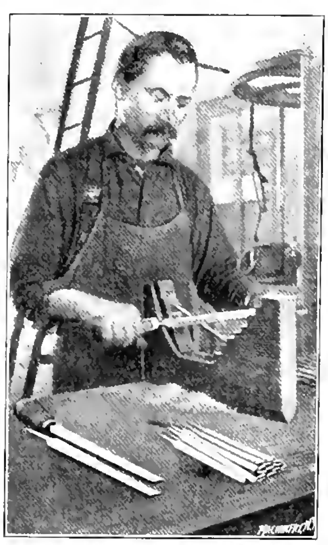


Fig. 7. "Stripping" File Blanks.

Two Instances of Hand Methods.

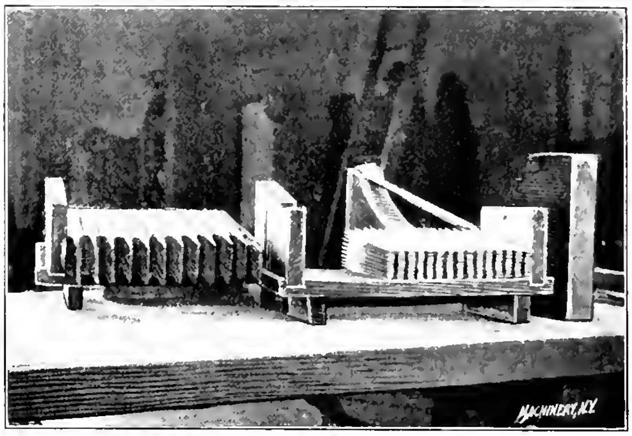


Fig. 8. Stacks of Blanks ready for Cutting—Note Uniformity of Height of Different Piles.

Fig. 9. A Row of File-cutting Machines.

The second step in the process is annealing. Fig. 4 shows the interior of a furnace with a stack of files ready for annealing. They are placed in two piles, with the tangs extending outward, so that the delicate tips of the files, which in tool work have to do much of the cutting, will not be injured by too intimate contact with the reflected heat from the hot walls of the furnace. The files are heated some four or five hours, according to the sizes of the blanks, and then are allowed to cool for twelve or fifteen hours before the furnace is opened for their removal.

After annealing, the blanks must be straightened, which is accomplished by heating momentarily over a gas flame and at the same time subjecting the file to a slight pressure at the point needed to bring it into shape.

The next step is grinding the blanks ready for cutting. Special machines are used for much of the grinding, a portion of one of which is shown in Fig. 5. The grindstone, *D*, does the grinding. The files are clamped to a flat plate, *A*, which fits in a holder, *B*, and is locked in position by the piece *C*. This holder reciprocates in a vertical direction and moves the faces of the files up and down against the surface of the rotating grindstone, the stone at the same time having a longitudinal motion crosswise of the files. Other grinding is done by hand, on grindstones, and in some cases on emery wheels,

the round files, for example, being finished in this way by means of a special machine in which the blank is held in a chuck having both a reciprocating and a rotary motion. The method of grinding depends to a considerable extent upon the shape and size of the file. After the cutting portion of the file is ground the tangs are then finished.

Before going to the cutting machines the blanks are finished by draw-filing or by "stripping," as it is called in this work. This is one of the instances where hand work enters into the making of the file. While the shape is determined mainly by the forging and grinding operation, it is necessary that the finishing touches should be put on by hand to insure that nicety in the forming of the blank that the expert workman so much desires. Draw-filing also produces a finish superior to grinding.

In Fig. 8 are stacks of files finished ready for cutting. There are some 15 or 16 files in each pile in the left-hand stack and so uniform is the thickness of the files that the top surfaces of the 12 piles that make up the stack form practically one continuous smooth surface.

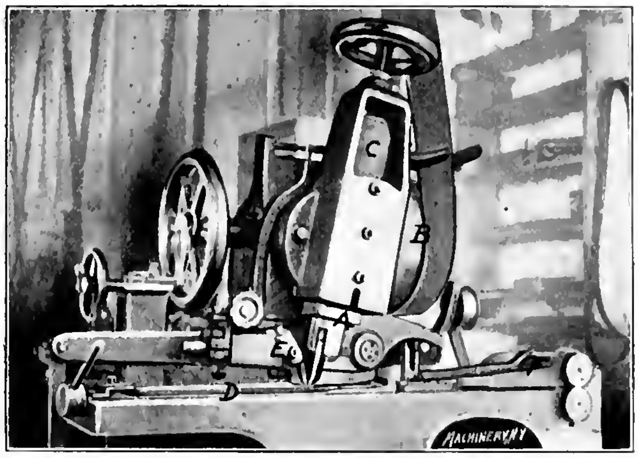


Fig. 10. Larger View of File-cutting Machine.

In Fig. 9 is a row of file-cutting machines, where the seventh operation is performed; while in Fig. 10 is a larger view of one of the machines. Contrary to what is probably the belief of many users of files, it is contended by these manufacturers, and they believe to have demonstrated, that there is no inherent merit in hand-cut files or even in irregular spacing for machine-cut files. For the most part, the files are cut with the teeth uniformly spaced, though in the case of files of certain types running to a point, provision is made for decreasing the pitch as the point is approached. The main requisites for a properly cut file are first of all, a blank of uniform hardness throughout, so that the teeth may have a uniform degree of sharpness; a properly shaped cutter, set at the correct angle, and a machine adjusted to give a blow of sufficient intensity to produce a sharp tooth at the pitch at which the file is being cut.

The file-cutting machines are manufactured by the Hess Machine Co., Philadelphia, and are a type quite generally used in the file industry both here and abroad. In Fig. 10, *D* is a file clamped in position for cutting, and is steadied at the point where the tool acts by the holder *E*. The slide carrying the file receives its motion by an extension which is drawn through the friction rollers, *F*; the cutter spindle, *A*, is driven by means of a ratchet cam through the pulley *B*. The cam raises the cutter spindle and compresses a rubber collar, *C*, which, when the high portion of the cam is passed, strikes the blow. The degree of compression of the rubber collar is regulated by the handwheel at the top, which thus determines the force of the blow. Files are cut very rapidly, the blows being delivered at the rate of 2,000 or 3,000 per minute, and when one side is finished the blank is turned over and the other side is cut. The blanks rest on a strip of sheet lead, to avoid injuring the teeth during the operation. Certain machines are fitted with a compound feed arrangement, by which the spacing of the teeth is changed, giving an "increment cut" as the point of the file is reached.

Files with fine cuts have their teeth formed by another method called etching. The process is a hand one and produces results akin to knurling in the engine lathe. The cutting tool is a long triangular bar, on the three edges of which are milled or knurled minute teeth similar in depth and shape to the teeth of the files to be cut. The file blank is clamped in position or, in the case of round files, is rotated gradually, and the cutting tool is passed over the blank in a manner similar to the movement of a file when draw-filing. The process is one requiring considerable skill. In the hands of a skilful workman the knurling tool can be given exactly the right angle and the right pressure, securing teeth of absolute regularity.

The class of work done by toolmakers is such as to require many files of special shapes, and in consequence a considerable portion of the product of this company is made to order, to conform to the wishes of its customers. This necessitates hand cutting in some cases, and in any event the work of the machine is supplemented by hand cutting, wherever it is required to give the desired degree of nicety. In Fig. 7 is a view of a hand cutter at work. It is a noticeable fact that nearly every trade has its own type and shape of hammer, and file cutting is no exception to the rule.

After cutting, the number and maker's name is stamped on the file and it then goes to the hardening room where the file is finished. It is here heated in a gas furnace and cooled in brine. Before the file is completely cooled it is straightened, and is then ready to be cleaned by the sand blast, in which latter process a fine clay powder is employed such as will not injure the teeth of the file. After inspection the product is ready to be oiled and packed in the shape in which it is delivered to the customer.

* * *

V-BLOCKS FOR PLANING KEYWAYS IN SHAFTS—JIG BLOCKS.

Fig. 1 shows a convenient V-block clamp made by Edward G. Herbert, Ltd., Manchester, England, for holding shafts on the planer platen while cutting keyways, etc. With this device no loose plates or packings are required, and the holding-down bolts are not disturbed when changing shafts. Every shaft is clamped exactly alike, the screw forcing the shaft into the vees bringing every one into exact parallelism, provided, of course, the V-blocks are accurately set at the start. It is obvious that this device can also be profitably used on the drill-press for holding shafts and other cylindrical work for drilling.

The box jig shown in Fig. 2 is another device brought out by this concern for drilling machine parts, it being possible

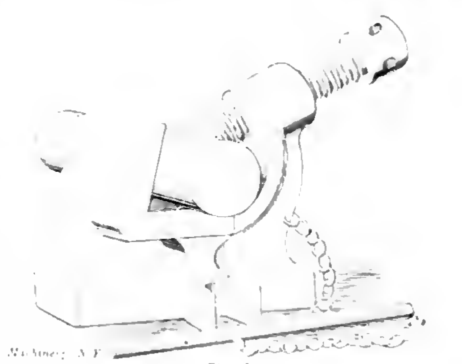


Fig. 1

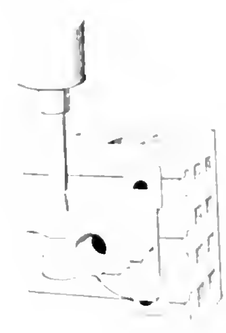


Fig. 2

by its use to drill or machine at one clamping of the work any surface parallel to the sides of the jig, which is accurately machined and squared on all sides. It can be readily understood that a set of such box jigs used in conjunction with a drill-press having a bracket attachment for guide bushings can be profitably employed on many classes of work for accurately drilling pieces for which it would not be profitable to make a regular drill jig. It should be possible to secure a fair degree of interchangeability by providing locating pins on the face of the box jig, and parallel strips clamped to the drill-press table which would fix the different positions of the jig and work for drilling. In fact it seems to us that this principle is one susceptible of many profitable applications in almost every shop.

ADVICE TO APPRENTICES.

JOHN MARK MAY.

The first thing to decide is what trade you are going to learn, for it is at the very start that a great many mistakes are made. It so often happens that a boy's main object is something that will pay him well, a trade that will hold him for a short apprenticeship only, or clean work that will admit of his wearing fine clothes. Again, perhaps the father or some influential relative (with good intentions) picks out the trade that he thinks he would like the boy to learn, regardless of the taste and ambitions of the boy himself; but if you get the opportunity, by all means learn the trade you have a natural taste for, remembering that there is a demand for first-class workmen in all trades, however crowded the middle and lower ranks may be. The chances of success are so much greater when the mind is kept upon the work being done, that it is well worth careful thought to select something that you have evinced a talent and liking for. Having made your selection, be thoughtful and conscientious, and do what you feel to be just and honorable to your employer and your fellow workmen rather than adopt rules and customs followed by careless, indifferent men.

Don't drink. I don't mean by this, don't get drunk, but don't drink intoxicating liquors at all. The premium on temperate men has never been higher than at the present time. You may be told that there are lots of good, intelligent men who drink and are holding good positions, and this we will have to admit, but at the same time I say that every one of those men would be better and of more value to their employers if they did not drink at all. Manufacturers and railroad companies are spending thousands of dollars annually on evening schools and in donations to the Young Men's Christian Association for educating their younger help and keeping them away from drinking resorts, and the employers find it profitable to do so. Be honest and truthful! When you are so unfortunate as to break or in any way damage a tool or make a mistake in your work, admit the fault frankly. Your foreman will soon find that he has one man whom he can trust and will gladly excuse any error he can, for, knowing that an honest, trustworthy workman feels worse about a faulty or spoiled job than any one else, and finding so many who hide and deny every mistake that there is the least chance of escaping blame for, he will enjoy rewarding those who deal squarely with him. Be polite at all times! Some of your associates in the shop may be rough, profane, and abusive, but if you continue to be polite and manly you will have an influence on them that is bound to be felt and will result in mutual benefit.

Strive to make your employer's business a profitable one, for if it is not profitable he surely cannot do well by you. Don't compare yourself with anyone else thinking that you are doing as much and as well as they, but just compare your work with the best you can do, remembering that as your efforts make your employer's business more profitable so they also make you a better workman and a more valuable employee. Be on hand promptly in the morning and walk out of the shop at the end of the day's work at the same gait that you came in. I know this is the exception rather than the rule, but I have never yet known an employer who, in looking for his best help, would pick out the men who dash out of the door first after quitting time at night. You cannot all meet with great success, but you can all do your duty and take advantage of the opportunities offered, and this is all that the very greatest have ever done.

A few hints as to the use of tools may not come amiss. The apprentice of the present day usually gets a better schooling on machine work than on hand work; therefore take advantage of every chance to learn points and get practice in filing and chipping. A much smaller proportion of this work is now done than formerly; nevertheless the man who can do it well has an advantage for general work. This is a micrometer age, but the old caliper is still a very necessary tool, and a few lessons from some of the older men who learned its value before micrometers were in general use will not come amiss. Old Chris, it seems, was brought up on calipers. He has no use for micrometers—they didn't have them in his younger days, and it is hard *sometimes* to teach old dogs new tricks, etc., and calipers are good enough for him. There is no mistake about it, he can do some excellent sizing with the aid of a caliper; not but that he could do better with a micrometer if he were not too stubborn to use one. He can, however, handle a pair of calipers to perfection and any apprentice who is favored with points on calipering from Old Chris is making a great mistake if he does not take advantage of them, for the caliper can generally be used to advantage together with the micrometer.

* * *

F Note

"CENTER-PRESSURE" STOP VALVE.

A new type of steam stop-valve is being introduced by J. Hopkinson & Co., Huddersfield, England, which embodies an interesting construction designed to overcome some of the faults of the ordinary type of disk valve. In the disk valve, especially when of large size, the springing of the valve body due to unbalanced internal pressure, has a tendency to distort the diaphragm and valve seat, and cause leaks. Another fault is the tendency to cut and score the seat when opening and closing the valve, owing to the high velocity of steam when passing through a constricted opening. Figs. 1 and 2 show the Hopkinson valve closed and open, and it will be noted that two opposing valve disks are employed instead of one. These disks work in opposite directions, of course, each being worked positively and independently by its own valve spindle, but only one handwheel is required. When

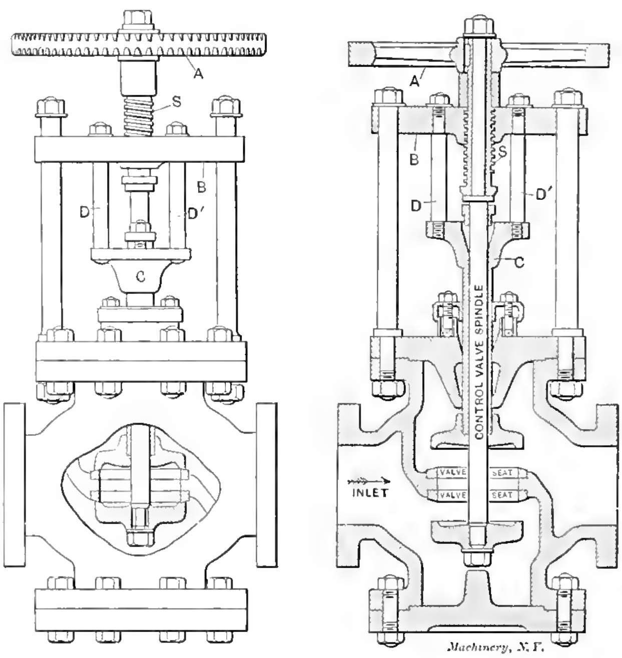


Fig. 1. Fig. 2.

the valve is closed the steam pressure holds the lower disk firmly to its seat, and in opening, the upper disk raises first. The rotation of the handwheel causes the hollow screw, *S*, to which it is keyed, to raise the floating bridge, *B*. This in turn raises the upper disk by means of its connection to the stem, *C*, through the studs, *D D'*. Further rotation of the handwheel after the bridge has reached the upper limit of its travel, forces the center spindle and lower disk downward against the steam pressure and actually opens the valve so that steam can flow through. Closing the valve is the reverse operation, the lower disk seating first and the upper disk last. It will be noted that closing the valve requires less effort on the part of the operator, as the steam pressure assists in closing the lower disk, and the upper one is closed against no resistance whatever so far as steam pressure is concerned. When the upper disk is forced tightly against its seat the screw pressure tends to balance the steam pressure on the lower disk and to prevent distortion of the diaphragm. The upper lid joint is relieved of all pressure when the valve is closed, and the stuffing-boxes may be packed under steam pressure when the valve is closed. The lower lid, or cover, permits the lower disk to be examined and repaired without dismantling the entire valve. The valve was developed for high-pressure and superheated steam.

LETTERS UPON PRACTICAL SUBJECTS.

SULPHUR AS A PACKING BETWEEN BED PLATES AND FOUNDATIONS.

Editor MACHINERY:

Running melted sulphur under the bedplate of a steam engine, pump, or any other piece of machinery, as a permanent packing between the bedplate and foundation is not by any means new, sulphur having been used for that purpose, for years; but as it has proved in my experience to be the very best material for the purpose of making a perfect packing, the sulphur expanding in cooling so as to fill perfectly the space between the under side of the bed and the masonry of the foundation, I heartily recommend it for that purpose. The method of performing the work is so simple that it can be accomplished by a neophyte if he will follow strictly the following directions:

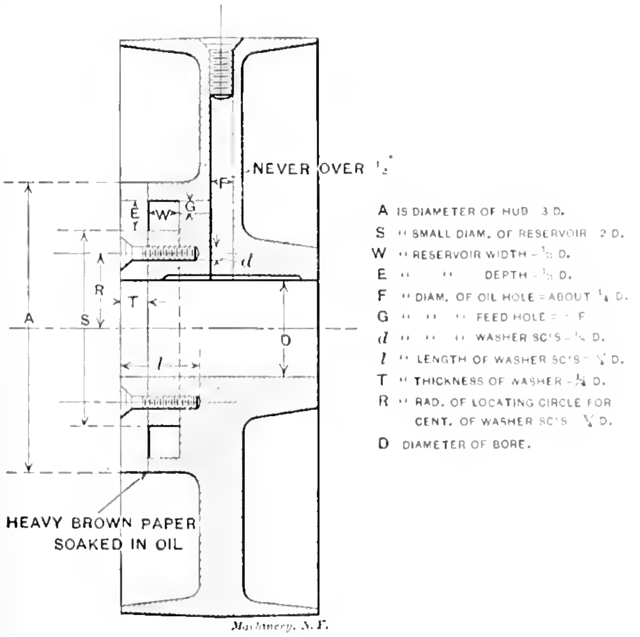
Level up the bedplate on iron wedges, placing them at such intervals as will not permit the casting to sag, leaving the space between bedplate and foundation from one-eighth to three-sixteenth inch high. Pack with well-worked clay close all around the casting, leaving risers or sprue holes at such intervals and of sufficient height to insure the space being entirely filled. Turn the nuts of the fastening bolts home to the casting all round. Melt the sulphur over a very slow fire, taking care that the sulphur is simply hot enough to become fluid. It will run like water. When it is just past the melting point pour into as many sprue holes as will allow the sulphur to run under the bed and, uniting in one mass, rise and fill all the risers or sprue holes. If run up full while in a fluid state the sulphur will expand in cooling, and all the fastening bolts will be found tight. Remove the clay, chip off the sprues and you have a smooth, neat joint, which will last indefinitely, if the waste oil from the engine or other machinery is not permitted to accumulate around the foundation; for oil will dissolve sulphur. If for any reason the foundation cannot be kept free from waste oil, clean the joint and cover it with a coat of paint. If the bedplate is an open one, cover the joint on the inside with a layer of putty, following with a coat of paint. C. E. MINK.

Syracuse, N. Y.

LOOSE PULLEY DESIGN FOR HIGH SPEED.

Editor MACHINERY:

Some time ago the writer was associated with an engineer in changing over a power plant, and among the problems which came up was the placing of a dynamo which required the use of a loose pulley that must run 1,750 revolutions per minute for about six hours per day. The cut shows the one designed and used, together with formulas for proportions.



Loose Pulley for High Speed.

The pulley may be designed to ordinary proportions, such as are given in MACHINERY data sheet of November, 1904, except the part of hub containing the oil reservoir, and for this purpose the proportions given in the cut are satisfactory. If, in the use of these, the dimensions do not give standard sizes for the screws in washer and oil hole, they may be changed slightly to the nearest standard obtainable; it is never necessary to have the oil hole over ½ inch diameter. Between the pulley and washer face is a heavy brown paper gasket soaked in oil before being put in place.

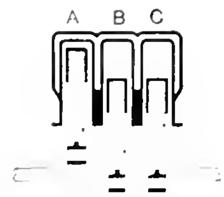
This pulley has been running about a year and a half, and it has never given trouble from heating. Its simplicity makes it easy to handle in the shop, and in this case it has given perfect satisfaction. JAMES A. PRATT.

Howard, R. I.

TABLES SHOWING THE SUCCESSIVE EVENTS IN THREE- AND FOUR-CYLINDER GAS ENGINES.

Editor MACHINERY:

I send you two tables, which I have made and found very handy in gas-engine work, thinking they may be of use to some of your readers. One table is for a three-cylinder engine and the other is for four cylinders, and both explain themselves so well that little need be added.

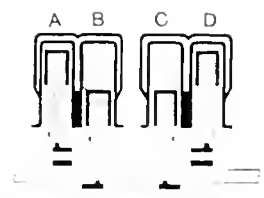


THE STROKE EVENTS OF A 3 CYLINDER GAS ENGINE

REVOLUTIONS	1ST HALF	2ND HALF	3RD HALF	4TH HALF
CYLINDER A	EXPLODE	EXHAUST	CHARGE	COMPRESS
" B	CHG. COMPRESS	EXPLODE	EXHAUST	CHARGE
" C	EXHAUST	CHARGE	COMPRESS	EXPLODE EXH.

Machinery, N.Y.

Successive Events in Three-cylinder Gas Engine Cylinders



THE STROKE EVENTS OF A 4 CYLINDER GAS ENGINE

REVOLUTIONS	1ST HALF	2ND HALF	3RD HALF	4TH HALF
CYLINDER A	CHARGE	COMPRESS	EXPLODE	EXHAUST
" B	EXHAUST	CHARGE	COMPRESS	EXPLODE
" C	COMPRESS	EXPLODE	EXHAUST	CHARGE
" D	EXPLODE	EXHAUST	CHARGE	COMPRESS

Successive Events in Four-cylinder Gas Engine Cylinders

If one wishes to know what is taking place in the cylinders of his engine at any given part of a revolution, he can tell at a glance by simply reading down one of the vertical columns in the table. The four-cylinder table shows there is an explosion for every half revolution of the engine shaft. The three-cylinder table shows an explosion in every half revolution, but there is an interval of one-sixth revolution additional between explosions, when there is none. For convenience the tables represent exhaust as commencing at the beginning of a stroke, whereas in practice it begins a little before.

Chelsea, Mass. R. L. WILLIAMS.

LATHE GEARING COMPENSATION FOR CHANGES OF LEAD DUE TO HARDENING.

Editor MACHINERY:

As nothing has been said of late in your columns regarding the shrinkage of steel in hardening, especially its effect upon the pitch of screws, I herewith submit a formula which will be found very useful to all having to contend with troubles of this kind. The formula, as given, is intended to aid in finding the ratio of change gears to be used when cutting a thread which is a certain amount longer or shorter in one foot than the same thread would be if regularly pitched. Of course this amount varies according to different makes and grades of steel, and no rule can be given for determining same; experience alone must be relied upon in that matter. Even when working with the most uniform grade of steel, and handling it with the utmost care, there is no sure telling whether the result will be shrinkage or expansion. However, if it has been found that a certain kind of steel has an invariable tendency to go one way or the other, it may be fairly well assumed that the same steel will vary in the same way in most cases, though the amount of shrinkage or expansion may vary somewhat from time to time. I have even observed exceptional cases where different parts of the same piece have shown considerable difference in the amount of shrinkage or expansion.

To overcome the troubles that would arise in fitting a correctly threaded piece into a hole tapped with a tap, the lead of which had become incorrect in hardening, it has become a practice to cut the tap with a lead such an amount longer or shorter than the regular one as has been found to be the average amount that taps made of the same steel will shrink or expand. The gearing of the lathe for such thread-cutting has always been regarded as more or less confusing, but the following formula will aid in finding proper ratio of change gears to use in such cases:

$a =$ amount thread is longer or shorter in one foot than the same number of threads would be, regularly pitched.

$n =$ nominal number of threads per inch on work to be threaded.

$l =$ threads per inch on leadscrew of lathe.

$r =$ ratio of gears in head of lathe.

$R =$ ratio of change gears to cut a thread a certain amount, a, longer or shorter in one foot than same number of threads regularly pitched.

Then

$$R = \frac{l \times r\ (12 \pm a)}{12\,n}$$

using plus for threads cut longer and minus for threads cut shorter in a foot than regular. The ratio of change gears having been thus obtained, the proper gears to use can readily be found by trial, suiting the gears on hand.

As before mentioned, nothing positive can be said about the amount of change likely to occur when hardening steel, but to give a general idea to those who are not familiar with its peculiarities in this respect I would add the following data concerning two kinds of steel much used by prominent manufacturers.

Atha steel has an average shrinkage of from 0.016 inch to 0.020 inch per foot, the larger value being the nearest correct amount for small diameters of work, that is, up to ⅝ inch. For larger diameters a proportionately smaller value of shrinkage between the limits given above can usually be assumed.

Jessop's steel changes about the least and is the most uniform of any kind of steel that I have heard of or had experience with. The average shrinkage of this steel is so small that it gives it a great range of usefulness in cases where other steels make trouble. The amount of change is only from about 0.004 inch to 0.006 inch per foot, these values being in proportion to smaller or larger diameters of work, as remarked above.

Of course many conditions will have to be taken into consideration to obtain satisfactory results. The amount of change not only depends upon the grade of steel, but upon the uniformity and amount of heat used when hardening, the rapidity and manner of cooling, and also upon the number of times the work has been through the fire. Data as given above are for steel annealed only once. In regard to the effect upon steel of repeated annealing, a few interesting remarks might be made. If after having been through the fire once the pitch of a tap is correct, and it is annealed and hardened again, each consecutive repetition of this process will invariably bring about a growing error. Again, if a certain kind of steel should be too long in the lead after the first hardening, a second, or if necessary, a third hardening is likely to bring about a satisfactory result in so far as concerns the pitch, though this is not advisable, as tool steel generally loses its good qualities by having been through the fire too many times.

HANS DAHLSTRAND.

Milwaukee, Wis.

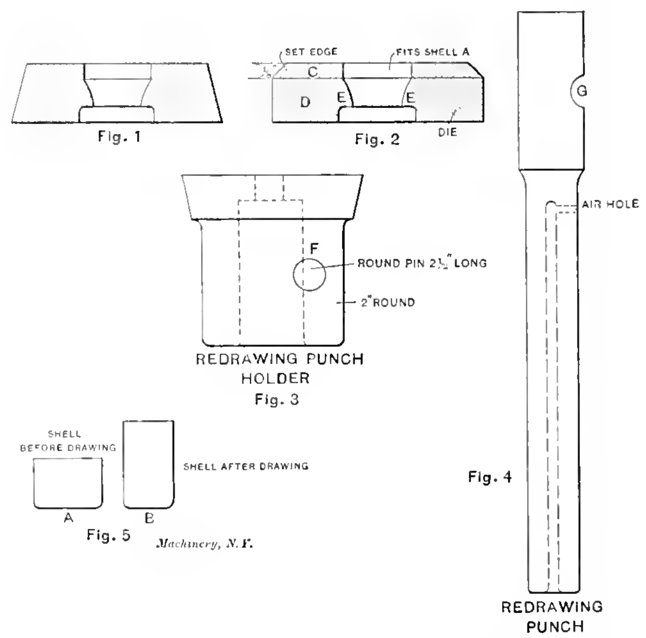
MAKING REDRAWING DIES ECONOMICALLY.

Editor MACHINERY:

Apropos of the bolster described by me in the January issue of MACHINERY I would like to add the following which may be of interest to your readers:

The description of the bolster in the January issue shows how it is used in connection with cutting and drawing dies. The same style of bolster is also used for redrawing dies when redrawing brass shells, thereby saving time and steel.

In the past it has been our custom to make our redrawing dies solid, as shown in Fig. 1, and fasten them in a bolster having four setscrews which are screwed up against the outside taper part of the die. Our present method, however, is to make the redrawing die in two parts as shown in Fig.



Making Redrawing Dies Economically.

2, of which the "set-edge" C is made to fit the shell A before it is redrawn. D is the redrawing die that draws up the shell B from the shell A.

These "set-edges" are made in various sizes, and are used in connection with different sizes of drawing dies. It sometimes happens that one "set-edge" is used with as many as ten different drawing dies. It is a well-known fact that when a redrawing die is worn out, it is shrunk, or in other words rehardened and is ground and lapped back to size. In making the die solid as shown in Fig. 1 the hole for the "set-edge" also requires grinding after the die is shrunk. It can, therefore, be very readily seen that time and steel are saved by making the redrawing die in two parts as shown in Fig. 2.

Perhaps a word or two would not be amiss at this time in regard to holding the drawing punch in the ram of the press. We have done away with the setscrew and check-nut method, and have adopted the following method with better results, of which very little explanation outside of the cuts shown at Figs. 3 and 4 is needed.

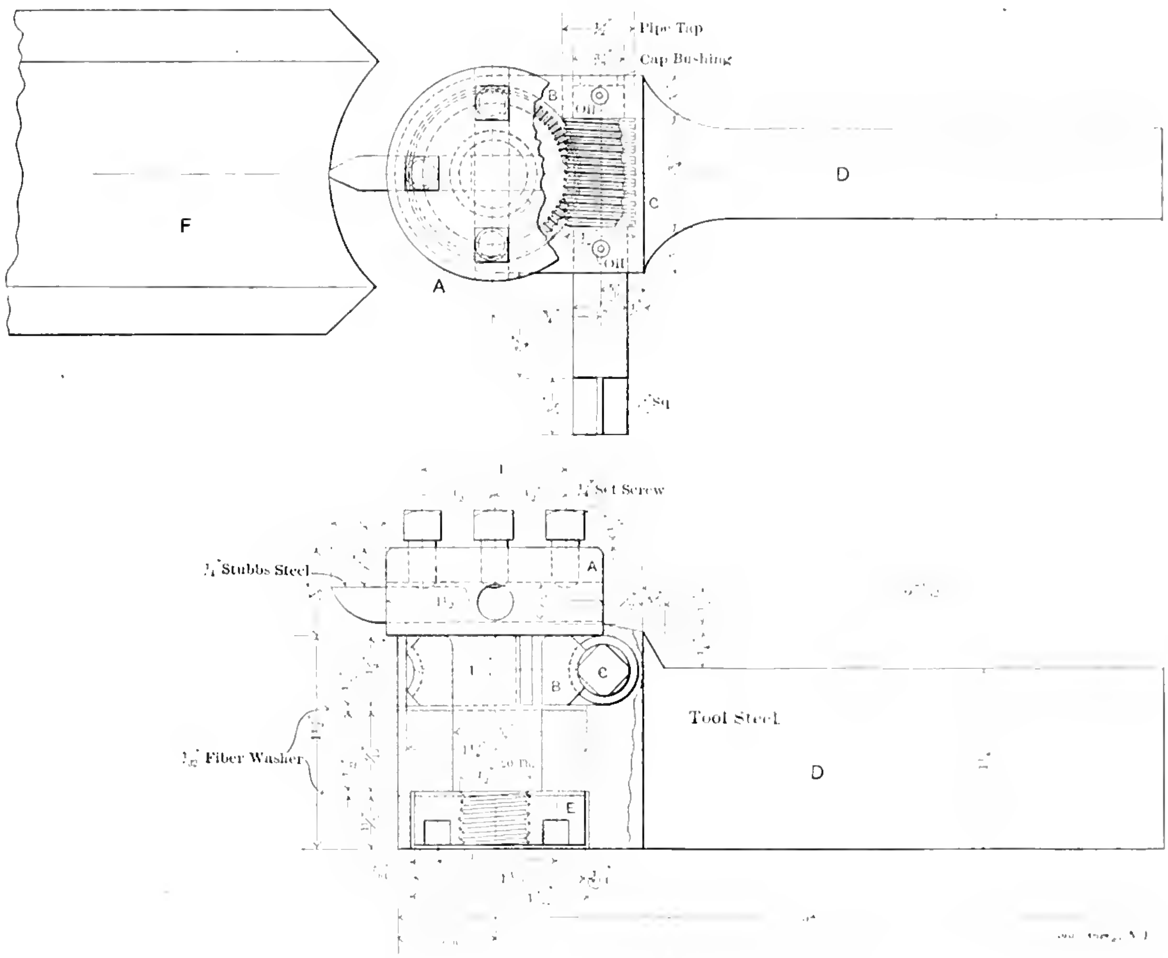
The gray cast-iron punch holder fits the dovetail channel in the ram of the press and is held in position by a key (not shown). The round pin shown at F engages in the half-round

groove *G* in the drawing punch, when the punch is placed in the punch holder, thereby preventing the punch from pulling out when the shell is being stripped from the punch by the sharp stripping edge shown at *E*. While the drawing punch as shown may appear to be made somewhat longer than is necessary for drawing up the shell *B*, it is made long so that the punch can also be used in drawing up various lengths of shells of the same inside diameter. C. F. EMERSON.

IMPROVISED DRAWING TABLE.

Editor MACHINERY:

The ingenious drafting board described in the February issue for those who have to do their drafting "on the wing" as it were, suggested to me that some correspondence school student or any mechanic who does drafting at home might possibly derive some benefit from the simple drafting table I find so convenient.



Figs. 1 and 2. Radius Lathe Tool for Wormwheel Blanks, etc.

A pair of one-inch iron butts on the cleats of an ordinary drawing-board fasten it to any table that is available; one with a drawer is preferred. Let the board be hung over the drawer and have the hinge on the table come under the edge. After the board is hung satisfactorily remove the rivets in the butts and substitute split pins for the same. The drawing board is then easily removed from the table when not in use by withdrawing the split pins so that the butts separate, the half remaining on the table not being objectionable. By pulling the drawer out different distances and letting the board rest upon it any degree of inclination desired is easily obtained. GEO. WASHINGTON.

RADIUS LATHE TOOL.

Editor MACHINERY:

At one time I worked on a lathe and had a number of worm gear blanks to turn very frequently. I got tired of roughing them out with a tool and finishing the arc with a scraper to a templet made for each sized gear, so I designed and made a radius lathe tool as shown in Figs. 1 and 2. I found it to be very useful, as it eliminated the use of a scraper and templet, and quickened the job very materially. As shown in the drawing, the tool has a turret head *A* with holes for four tools which are held by setscrews. By having four tools in the turret each one can be set for a different radius if desired, which saves changing tools when different sized gears are cut. The turret is fitted with a wormwheel *B* in which engages the worm *C*. The original design of the tool provided for 1-32 inch fiber washers between the worm and the shoulder of the holder *D*, and between the nut *E* and the holder. These, however, were omitted as the slow motion of the tool made their use unnecessary. In using the tool, I would first take an ordinary brass roughing tool, and rough the arc of the wormwheel, *F*, out by my eye, and then set the radius tool to the proper position and length, whereupon a handle on the square of worm *C* was used to slowly revolve the tool to finish the wormwheel to the exact arc required. F. H. WHIPPLE.

Schenectady, N. Y.

COMPRESSED AIR AS AN AID TO FAN BLAST IN FORGE SHOP.

Editor MACHINERY:

During an extra rush of work in the blacksmith shop, caused by engine failures and snow blockade, something extra in the way of noise was heard in the fan corner. The engine was stopped and an examination showed that every blade of the fan was broken off close to the hub. A new fan on short notice was out of the question, but the difficulty was quicker overcome by calling in the pipe gang and piping the forges for compressed air. The fan conduits were laid in the ground and connected to the forges with 2-inch pipe. These pipes were disconnected and taken to the drill-press and holes for $1\frac{1}{4}$-inch pipe drilled in them. The ends of some short pieces of $1\frac{1}{4}$-inch pipe were plugged and 1-16 inch holes were drilled through the plugs. One of these short pieces was thus inserted in each 2-inch pipe and connected to the air mains with a $1\frac{1}{4}$-inch valve convenient to the blacksmith's hand. By leaving the slide valve in the fan pipe open, the velocity of the jet of air draws quite a volume of air through the fan conduit, giving a good soft blast.

After fan was repaired the air system was left intact, and the

following are a few of the good points of this system. If the fan belts break or run off, or if the engine slows down, because of an extra heavy load, thus making the fan blast insufficient, or if the engine is stopped for any cause for a few minutes, the blacksmiths have only to open the air valves and go on with their heats. It is also convenient for round-house work, nights and Sundays, as the air supply is independent of the engine and the shafting need not be run for short jobs.

Malone, N. Y. A. E. MITCHELL.

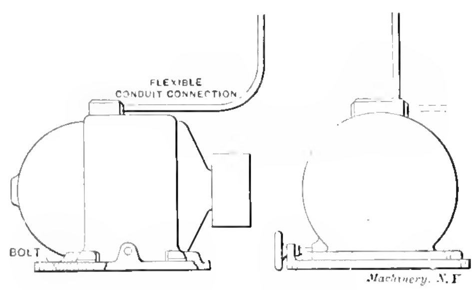
SMALL MOTORS AND DYNAMOS.

Editor MACHINERY:

Elmer E. Warner.

In the manufacture of dynamos and motors the multipolar ring type of generally high efficiency is much used, and I would like to suggest specifications for certain features of construction for this type of motor which, if adopted, would assist in creating a standard type, much to the benefit of users of such apparatus. Let us briefly outline some requirements of the general service for the smaller sizes.

First, it must be simple, efficient, durable, automatic and compact. It must be self-contained; that is, requiring neither extra oil pan nor boxing. It must be adaptable to various locations and modes of drive. Second, it must have the degree of insulation resistance prescribed by the National Code for installations of its capacity, so that it may be directly-connected to conduit systems or machines of any description without the use of extra or extraneous insulation for shaft or bedplate. Third, all current-carrying or "live" parts must be under the general surface. Armature leads and field connections should be carried up *inside* the frame to large and rigid binding posts on a thick insulating block on top of the machine, protected by an iron case or projecting ribbing. These posts should be plainly stamped to facilitate proper connection and provided with lugs where the current flow exceeds 33 amperes. The nameplate should be on the cover of this case or face of ribbing, and the words "Keep Clean" should be cast in large rounded letters just below. Solid or gauze paneled covers should be provided according to conditions of service.



Proposed Motor Outline Design.

Fourth, it should have the greatest possible symmetry, smoothness and simplicity of contour. All corners should be well rounded and projecting bolt heads, nuts, etc., avoided. It should be well filled, heavily enameled, and painted a neutral and unobtrusive color. This subserves cleanliness, reduces the liability to injury from accidental contact, and is true art and good taste.

The outer end of the bearing at the commutator end of the machine should be capped over flush with the casing. The sliding base used for the belt drive should be a ribbed plate with a low rounded lip around the outer edge to catch any oil that may be spilled in filling oil wells. The feet of the frame should dovetail into this plate, as indicated in the sketch, and one adjusting screw be provided, operated by cheap ratchet with short pipe handle, or a handwheel. Bosses should be provided at corners for holding down screws, as indicated.

For direct connection this machine would be furnished, of course, minus the sliding base and with feet drilled and planed only on the bottom. E. E. WARNER.

Brooklyn, N. Y.

ELMER E. WARNER, born at Newton, N. J., 1871, attended high school and later took an evening course at Pratt Institute, Brooklyn. He served his apprenticeship with the E. W. Bliss Co., and has since worked for the Excelsior Electric Co., the C. & C. Electric Co., the New York Navy Yard, and the Electrical Bureau of New York City. He was machine shop foreman, then superintendent of electric construction and installation, and he now pays special attention to shop organization for electric construction work.

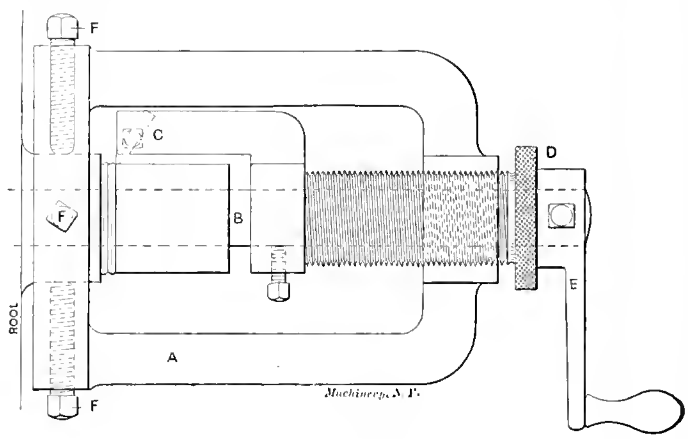
DEVICE FOR TURNING STEAM ROLL NECKS.

Editor MACHINERY:

Having in mind a job I was once called upon to do in a dyeing plant, and believing it might be of interest to some of the readers of MACHINERY, I will endeavor to describe it.

The job mentioned was repairing a mangle, which was used in drying the warp; it consisted chiefly of a series of large rolls which were about two feet in diameter, and twenty feet long. They were built of sheet copper, and brass heads with hollow shanks, being constructed this way to hold steam which assisted in the drying process. The shanks were run in stuffing-box bearings which, of course, in time caused them to become worn to such an extent as to quickly eat the packing, and make a leakage of steam and water.

There being no machine shop within a radius of several miles with facilities for turning the roll shanks, and being unable to find any one who cared to assume the responsibility of moving them without injury, it dwindled down to the necessity of a fixture by which we could turn them in the room; this was successfully matured in a comparatively short space of time.



Fixture for Turning Steam Roll Necks.

The device was in the form of a hand fixture as shown in the sketch. The holes in the shanks having been reamed 1¼ inches diameter while in course of construction, all that was necessary to make them all one standard size was a hand reamer to clean out the dirt and corrosion. This furnished one point to work from, as it was found the holes lined perfectly, and the bar *B* was made 1¼ inches diameter to fit the holes. In placing the fixture *A* ready for operation the knurled screw *D*, which is the device for feeding, was screwed back until the end was flush with the inside of the frame. The bar was inserted in the hole in the shank, it being long enough to have a full bearing in the hole at all times. When the tool was within about 1-16 inch of the end of the shank, the four setscrews *F* were tightened upon the neck of the shank (which was not to be turned off) and were so adjusted as to allow the bar to turn freely. When the device was in operation the several parts which come in contact with the feedscrew created nearly sufficient friction to cause it to feed itself.

This device proved to be a great time-saver and complete success in every detail; on several occasions I have set it up and turned a shank in half an hour.

New Haven, Conn. OTIS D. STORER.

COMBINATION FORMING DIE.

Editor MACHINERY:

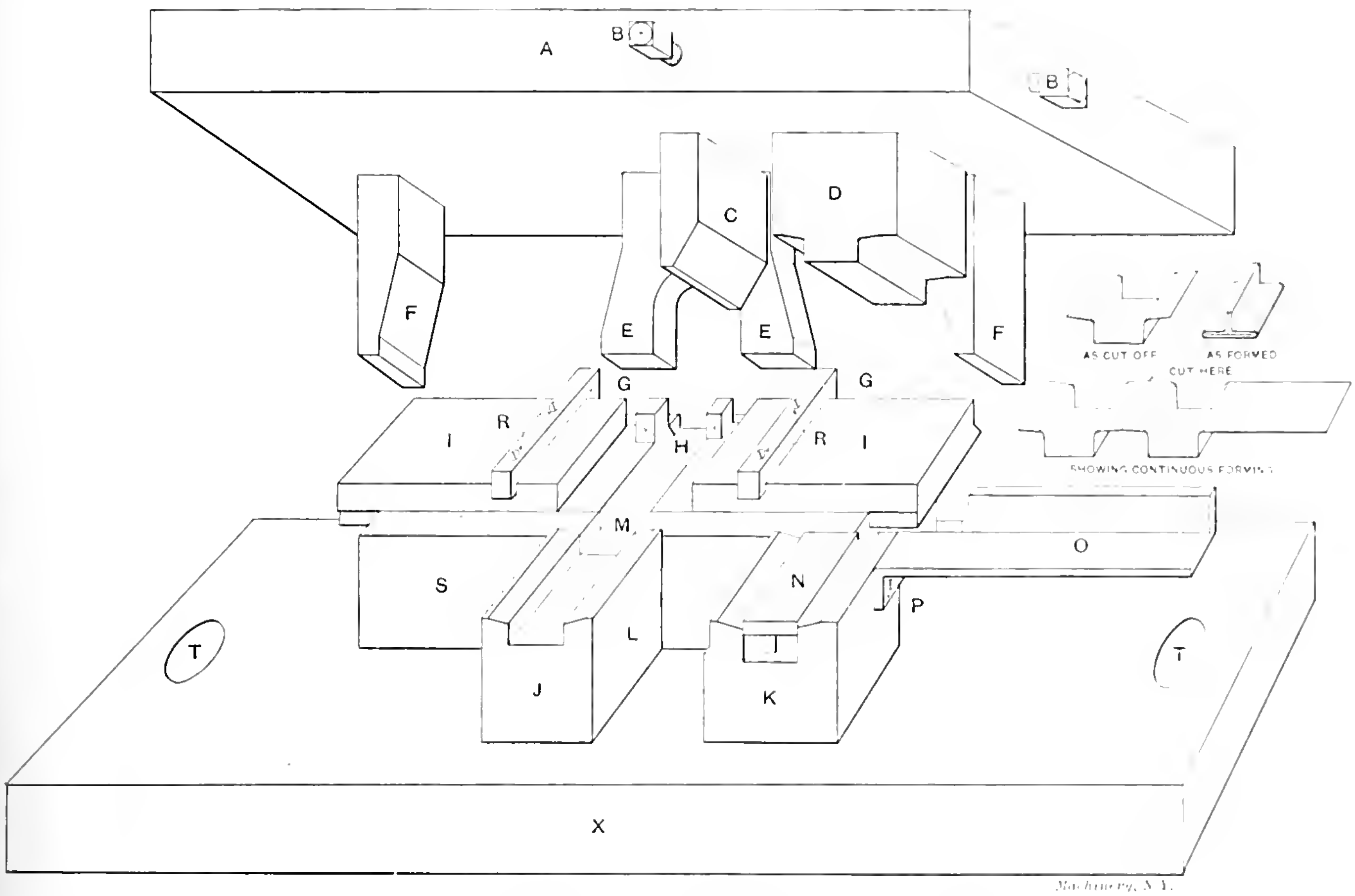
The cut shows a combination forming die, for shaping the piece shown at the right. It is of composite construction, and was designed with a view to produce the article as cheaply as possible. The lower half of the die includes the pieces *I*, *J*, *K* and *G*, which are of tool steel, while the piece *S* is machinery steel, and *X* is cast iron. *O*, which is a piece of angle iron,

is fastened to the piece *K* by means of two screws, *P*. The upper part will be described further on.

The stock is cut to the desired width on the square shears, and after the stock has been cut, it is placed on the guide, *O*, which keeps the piece in alignment while in the continuous progress of forming, as it is fed into the forming die, *K*. Die *K* is machined to the desired shape, and is cut a little deeper than the piece *J*, to allow of the cushion plate, *N*, being inserted and still give the required depth of the piece to be formed. After the piece to be formed has been placed on the guide, *O*, and shoved to the further side of the forming block, *K*, with about ¼ inch projecting over (that being about the amount of which the metal will draw in), the press is tripped, and we get the first form. The piece is then shoved along until it strikes the block, *J*, on the side marked *L*, which measures off the exact length, 1½ inches, for the next form. The press is then tripped again, and we get the second form as shown in the sketch "Showing Continuous Forming." It is then fed into the block, *J*, which is of the same shape as the piece formed, and the press is tripped again, which gives us another form, and at the same time cuts the piece off, as shown in

E, are also made of tool steel, and are given the same degree of taper as the fingers *F*. The piece is fed into the die as described, and on the descent of the ram the fingers *F* force the slides *I* inward and form the piece to the desired shape as shown. The fingers *E*, working against the pieces *G*, on the upward stroke force the slides back to their normal position, and the die being worked in an inclined press, the formed piece slides out of the back and a new one slips in. Thus the continuous forming continues until the strip is gone. It will be noticed that there is about ¼ inch left straight on the fingers *F* and *E*, so that they are always in contact with their respective working parts. A portion of the fingers *E* is cut away as shown, so as to allow of the formed pieces sliding through.

This die is fitted to a press having 1¾ inches throw, and is fastened to the bed by means of the holes *T*. The parts *F*, *E*, and *C* are held in position by setscrews, *B*, while the other parts are held by means of filister screws and dowel pins, as one cannot depend on a screw to keep a thing perfectly in its place. The parts *F* and *E* must work in harmony with each other and both have the same degree of taper. *A* is of cast iron, and



Combination Forming Die for Forming Range Fixtures from Sheet Metal

the sketch, "As Cut-off." This die is worked in an inclined press, and after the piece has been cut off, it is fed by gravity into the closing-in die, *M*. *L* is a cutting face, and *C* is the cutting-off punch. The block is slightly cut away, as shown, to allow of the metal being drawn as equally as possible from both sides. The cutting-off punch, *C*, is left about 1-16 inch longer than the form block or punch, *D*, and cuts the metal off before the metal commences to form; it is tapered as shown so as not to interfere with the other portion of the metal being formed.

After the piece has been cut off, and on the ascent of the ram of the press, the piece slides into the portion of the die marked *M*, and against the pins or fingers, *H*, which prevent the piece from falling through the die until it has been formed. The block, *S*, is made with a dovetailed groove, and the pieces *I* are made a nice working fit therein; the fingers, *F*, which are given the right degree of taper to produce the necessary travel of the sliding pieces, *I*, are of tool steel and hardened, and have ¼-inch taper on the inclined parts The pieces *G* are tool steel hardened, and are held in place by the screws *R*. The fingers,

J, *K*, *G* and *I* are all hardened and drawn to a dark straw color. There is also a shank fitted to this die which is not shown, which holds the upper half of the ram of the press while in operation. It will be noticed in the sketch that the piece is formed a little less than right angles, so that in the closing-in operation there is no chance for the metal to spring apart and leave the piece open at the top. There must be allowed twice the thickness of the metal either in the slides, *I*, or the bottom of the die, *M*, for the metal while in the operation of closing in. After the third stroke of the press we get a finished piece every stroke, and they can be made for about three cents per hundred

Lorain, Ohio. W. VAN ORMAN.

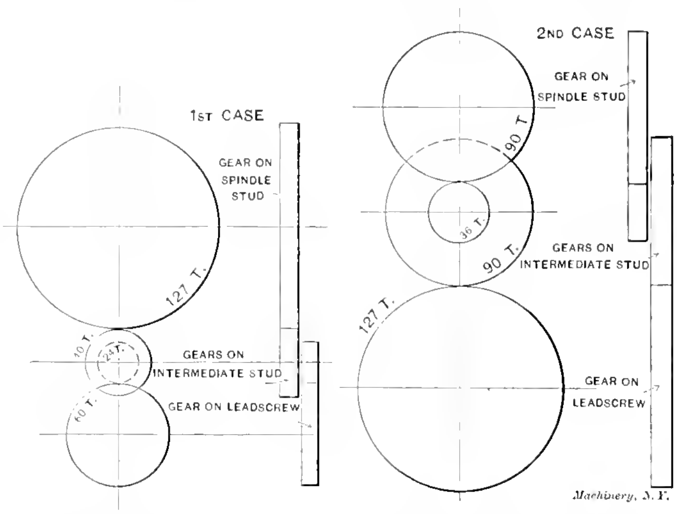
CUTTING ENGLISH THREADS WITH METRIC LEADSCREW.

Editor MACHINERY:

In your February issue I read with much interest an article by Mr. E. Wopalitzky in regard to cutting English system threads, using a metric leadscrew. However, his method seems to me to be rather difficult and uncertain, and the way by means

of which he obtains his result is more complicated than need be.

In the first place, he cannot find the proper gears to use excepting by trial, and having six change gears to deal with, it will require much time and patience to find the correct ones—admitted that *correct* ones could be found; but in the second place, it must be remarked that there is only one way to cut an English thread, using a metric leadscrew and *vice versa*, and that is by introducing in the train of gears a gear with 127 teeth, which will be explained later. As in the case referred to in his article no such gear is used, I cannot see how a correct lead possibly could have been obtained. In the third place, admitted correct results could have been obtained, it seems to me that the expense of making the two studs and



Figs. 1 and 2. Lathe Gearing with Translating Gear for Metric Threads.

arranging them in a suitable manner on the lathe would by far exceed the cost of making a 127-tooth gear, when considering that this gear would always be used in a *single* compounded train when cutting threads of above description; besides, on most lathes, especially on those for smaller work, it would be difficult to find room for a train of more than four change gears. I thought, therefore, that it would be of value and interest to the readers of MACHINERY to get a complete and correct account of the only way possible to cut an English thread by using metric leadscrews and *vice versa*.

1. Metric leadscrew—English thread to be cut.

As there are 25.4 millimeters in one inch, the number of threads per inch on the metric leadscrew equals 25.4 divided by the pitch of the leadscrew expressed in millimeters; in other words, if a is the pitch of the leadscrew in millimeters and C is the number of threads per inch of same leadscrew, then

$$C = \frac{25.4}{a}$$

Let c be the number of threads to be cut on the piece to be threaded, then the ratio of the change gears is

$$\frac{C}{c} = \frac{25.4 \div a}{c} = \frac{25.4}{a \times c};$$

change gears conforming to this ratio will cut an exactly correct pitch. Multiply both denominator and numerator by 5, thus making the formula read:

$$\frac{127}{5a \times c}$$

Thus it will be seen that if a gear with 127 teeth is introduced in the train of gears and other gears are selected, as indicated by the values a and c, the correct change gears can be found without any trouble whatever. For example: Leadscrew has 4 millimeters pitch $= a$; and 5 threads per inch to be cut $= c$.

Then the ratio of gears $= \dfrac{127}{20 \times 5} = \dfrac{127 \text{ driver.}}{100 \text{ driven.}}$

If the lathe has a capacity of taking a 127- and 100-tooth gear in a direct train, these gears are used; otherwise, gears have to be compounded and it is readily seen that trains of gears composed as follows:

$$\frac{\overset{\text{drivers}}{127-24}}{\underset{\text{driven}}{40-60}};\qquad \frac{\overset{\text{drivers}}{127-30}}{\underset{\text{driven}}{50-60}};\qquad \frac{\overset{\text{drivers}}{127-32}}{\underset{\text{driven}}{64-50}}$$

and many other combinations will serve the purpose, the gears above being such as generally go with any lathe. The 127-tooth gear in this case ought to be mounted on the spindle stud.

2. English leadscrew—metric thread to be cut.

Suppose $d =$ the number of threads per inch on the leadscrew,
$e =$ the pitch in millimeters on the screw to be cut, and
$f =$ the number of threads per inch of same screw,

then referring to what was said in the first part of the article, $f = \dfrac{25.4}{e}$ and the ratio of the change gears $\dfrac{d}{f} = \dfrac{d}{25.4 \div e} = \dfrac{d \times e}{25.4} = \dfrac{5d \times e}{127}$.

Then, as before, it will be readily seen that even in this case a gear with 127 teeth is necessary, and no other gear can replace same, neither in the first case nor in this, as 127 is a *prime factor*. For example: Leadscrew has 8 threads per inch $= d$, 6 millimeters pitch to be cut $= e$; then ratio of gears $= \dfrac{40 \times 6}{127}$; then trains of gears composed as follows:

$$\frac{\overset{\text{drivers}}{96-90}}{\underset{\text{driven}}{127-36}};\qquad \frac{\overset{\text{drivers}}{100-60}}{\underset{\text{driven}}{127-25}};\qquad \frac{\overset{\text{drivers}}{80-75}}{\underset{\text{driven}}{127-25}}$$

and others can be used in this case; of course the 127-tooth gear ought to be mounted on the screw in this case.

Hartford, Conn. A. L. VALENTINE.

TOOL FOR BORING ROTARY PUMP CASING.

Editor MACHINERY:

Louis Myers.

Fig. 1, next page, shows a rotary gear pump body, built by an automobile concern, and Figs. 2 and 3 show the fixture used in boring same. In this style of pump it is very important that the distance between centers, and the size of bores shall be exact. This fixture can be recommended to do the work satisfactorily, both as regards quality and quantity. The device essentially consists of two parts, the upper part, *A*, being the frame carrying the cutter spindles, and *B* the fixture for holding the pump body. Frame *A* is of cast iron bored to receive two spindles, the distance between the centers of each being exactly the same as in the pump casing to be bored, *i.e.*, 1½ inches. One of the spindles has a taper shank fitted into the drill press spindle, and motion from it is transmitted to the other cutter spindle through spur gears mounted at the lower ends. The gear ends of these spindles are bored to receive the boring cutters, each of which are 1 7-10 inches in diameter for finishing and 1-32 less for roughing. These cutters are of the ordinary four-lipped boring type, made so as to bore and face the bottom, and since the spindles run in opposite directions, it follows that a right and left-hand cutter is required. It is also obvious that they must be so mounted that the teeth do not interfere, since the circles described by the ends of the teeth intersect. As intimated, two sets of cutters are used, one for roughing and one for finishing, 1-32 inch being left for the finishing cut. The face part of the roughing cutters should be ground by hand so as to make the cutting edge irregular, or nicked, in order to allow the cutter to bite freely under the scale and save chipping.

The fixture *B* consists of two cast-iron plates held together

LOUIS MYERS was born in Irkutsk, Siberia, 1871. He came in 1881 to the United States, attended school for a year, and then went to work. He served his apprenticeship with the Pratt & Whitney Co., later had charge of the tool-room of the Searchmont Automobile Co., and is now general foreman with the Cunningham Mfg. Co., Philadelphia. Mr. Myers attended evening school for some time, and now keeps up his study of tool-making by a careful perusal of technical papers.

by four studs at the corners. The guide shafts, C, are screwed into the top plate, and the projecting lugs on A are bored for a nice sliding fit thereon. The pump casings to be bored are first planed. They are then placed in the fixture with the planed surface against the top plate, as indicated in the cut,

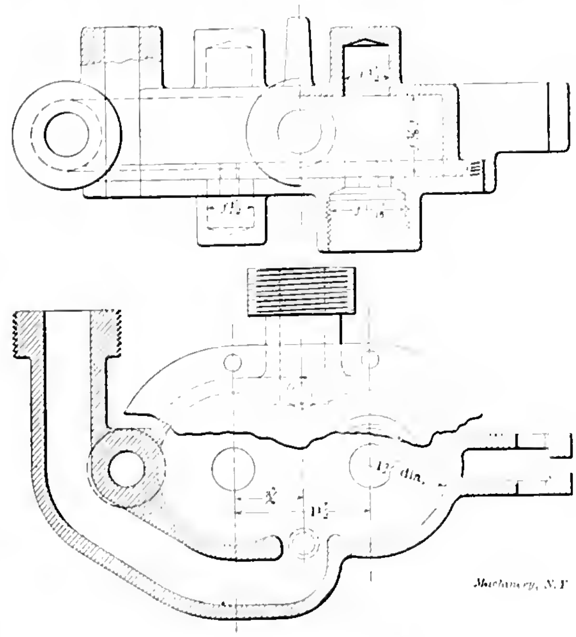
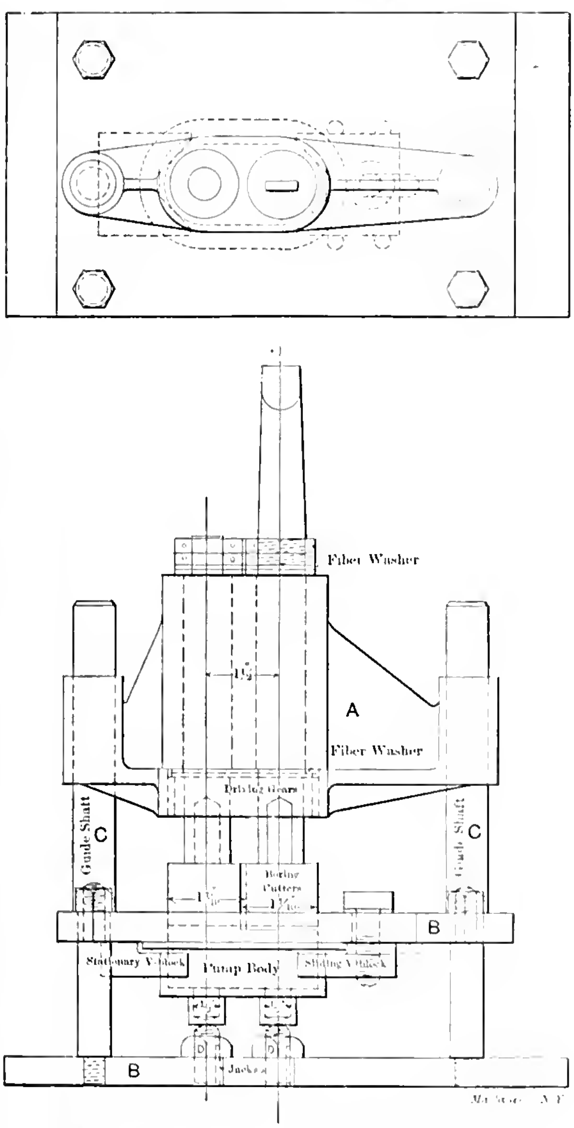


Fig. 1. Rotary Pump Casing.



Figs. 2 and 3. Tool for Boring Rotary Pump Casing

Fig. 3, one end of the casting being held against the stationary V-block and the other by a sliding V-block. For convenience in operation, the sliding V-block is clamped with a thumb-screw. The two jacks, D, are then screwed against the bottom and the work is ready for boring. The ½-inch holes for the ends of the shafts of the pump gears are bored afterward by a separate jig not shown. It consists of a cast-iron plate with two circular locating pads fitting closely within the bored recesses made by the tools, Fig. 3. Half-inch guide bushings are located within the centers of these pads to accurately center the boring tool.

To get satisfactory results with this fixture, it must be made very stiff, the bearings should be long, and the gears and spindles a good fit. It is best to make the bearings of bronze and the gears of good steel. If properly constructed, it will do a surprising amount of work, and will bore a great many castings without any attention from the toolmaker, except in the matter of grinding the cutters, which does not require a skilled operator.

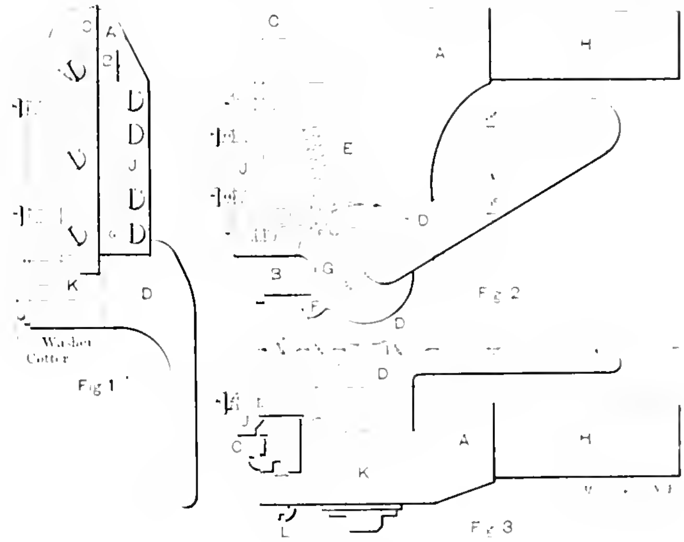
L. MYERS.

Philadelphia, Pa.

A TURRET PARTING TOOL.

Editor MACHINERY:

One objection to the regulation V-block and parting tool used on the turret lathe is the mark it leaves on the work; also the time required to back up the tool, when operated by screw feed. The tool shown in Figs. 1, 2 and 3 was designed to overcome these objections, particularly the one of slow return. The cutting tool C is mounted in a movable sliding block B, which is attached to a coil spring located in the interior of the casting at E. The slide is operated by the lever D, which has a cam-shaped tooth at F; this cam engages a lug G on the slide and forces the tool into the work as the handle is rotated. Fig. 2 shows the tool with the slide clear back, and the dotted lines show the slide forced into the position it should occupy when



Turret Parting Tool

the point of the tool has reached the center of the work. In this position the cam F is just ready to slip off the point of the lug G on the slide. The further movement of the handle allows the spring E to return the slide instantly to its backward position, and the operator then turns the handle clear round in order to engage the cam on the back side of the lug G.

The construction of the tool is simple. It is made of cast iron, the end H being turned to fit the hole in the turret. The slot for the cam on lever D is cored out, a good-sized lug being provided at this point, in which is drilled a hole for the round pin K on the lever D. The lever is held in place by a washer and cotter key at the bottom. The groove for the sliding tool holder B and the spring E are also cored out, and the groove, of course, is machined. The slide B and tension piece J are both made from machine steel finished all over. A half V-groove is planed in the bottom of this slide for the taper point machine screws L, Fig. 3, which act as gib screws. There should be no looseness in any of the parts, for smooth close working is an absolute necessity for rapid, accurate work. This tool with a generous oil supply has produced from 3,000 to 4,000 pieces cut off with one grinding of the tool. It is obvious from the construction that the parting tool should be set in the slide B so that the cutting point just reaches the center when the lug G slips by the point of the cam F.

C. NEIL.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO BABBITT CROSSHEADS.

Some classes of engines have a single bar guide, with a crosshead of the enclosed type, three sides of which are babbitt lined. The crosshead is put in place on piston rod and guide and the babbitt poured in. I find it an advantage to coat the guide heavily with white lead before pouring the babbitt. This allows the crosshead to be removed with little trouble and requires but little scraping to get a good running fit.

South Portland, Me. J. V. N. CHENEY.

LOCOMOTIVE BOILER TEST PUMP.

A hand test pump that took six men to operate in relays of three was certainly not popular with the working force. To fill a "long-felt want" a small boiler feed-pump that had been rusting its life away in a dark corner was brought forth, cleaned, oiled and mounted on a light four-wheel truck. With 90 pounds water pressure on shop mains and 100 pounds air pressure at the throttle one man now easily does the work that formerly required six. A. E. MITCHELL.

Malone, N. Y.

TO MEND BROKEN OIL STONES.

A valuable oil stone can usually be saved when broken, even if there should be several pieces. The pieces must first be thoroughly cleaned and all oil driven from the fractured surfaces by heating on a hot iron plate. After the surfaces to be joined are properly prepared, they are well dusted with powdered shellac and again heated until the shellac is melted and flows well into the joints. The heating should be done on a smooth metal plate and the stone kept from the flame; otherwise it is likely to crack in other places. Neither must it be overheated, for the same reason. When the shellac has melted, the parts are pressed together and clamped until they have cooled. A joint so made often lasts as long as the stone, and if carefully made leaves no mar in the cutting surface.

Chicago, Ill. O. M. BECKER.

PLANING ENGINE BEDS.

While looking through a shop in Western Pennsylvania some time ago, I was interested in the planing of center crank engine beds (12 H. P.). The bed was first centered at each end, there being a lug cast on crank end, and as it was of the overhung cylinder type, that end was easily centered. The bed was first put in the lathe and the cylinder end turned; then it was put on the planer bed *on centers*. The bed was trued up with blocking and the planing begun.

The man in charge of same showed me a set of gages. They were made with a round cast-iron base in which was inserted a rod of proper length, and on which was a projecting arm fastened with a screw. The gage was placed on the planer table and the arm indicated if the surface was planed to the proper point. There was no setting of gages for different heights, as there was one provided for each different surface planed; the result was that from six to eight beds were planed in ten hours. F. H. J.

GRADUATING FOR DEGREES IN THE INDEX HEAD.

The following shop kink may possibly be known to a large majority of machinists and toolmakers, but there is always a large number of men who do not know about some one thing that they will want to know about pretty bad some time. It is not every man who knows just how to manage the index head on a milling machine, so as to graduate to degrees. For instance, suppose a machinist is given a job on the milling machine which calls for a finished part on a round piece to be 70 degrees from the first center to the second, 80 degrees from the second center to the third center, 90 degrees from the third center to the fourth center, and 120 degrees from the fourth center to the first, thus making one complete revolution of a circle or 360 degrees.

To proceed with the job, take the index plate which contains the 18-hole circle and arrange the index pin to work in this circle. If there are 18 holes in one complete turn of the indexing handle and it takes 40 turns of the handle to make one revolution of the head, then 40 turns $\times$ 18 holes $=$ 720 holes in 360 degrees. Therefore 720 holes in the complete circle $\div$ 360 degrees in the circle $=$ 2, number of holes on the index plate for one degree. Then to find the number of turns and holes for each number of degrees multiply the 70, 80, 90 and 120 degrees by 2 and the result is the number of holes for each turn of the index head. To prove that this is right:

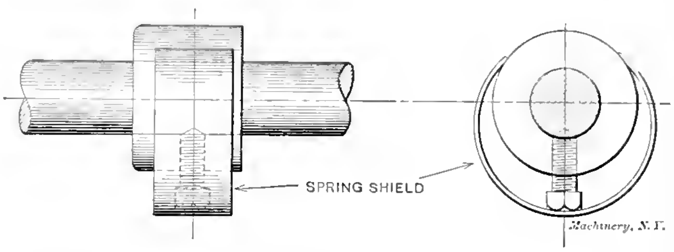
70 degrees =	7 turns	14 holes.
80 degrees =	8 turns	16 holes.
90 degrees =	10 turns.	
120 degrees =	13 turns	6 holes.
	38 turns	36 holes.

38 turns and 36 holes = 40 turns of the index handle or one complete revolution of the index head or center.

Detroit, Mich. C. J. SHAW.

SIMPLE SAFETY DEVICE FOR SETSCREWS.

The blow of the eccentric shield may be felt but the "bite" of the sharp-angled head is effectively muzzled by the thin spring over it; not very pretty perhaps, but likely to save clothes, skin, and possibly bones.



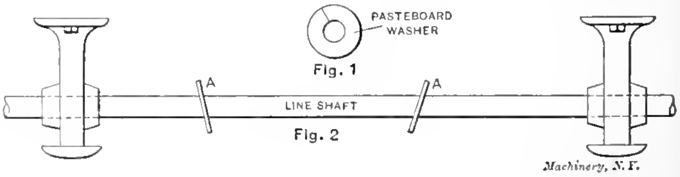
It does not matter where the setscrew is, whether in collar or hub, a piece of sheet steel plate can be curved to fit snug—spring on, in fact—which will keep the head from undesirable interference with stray fingers, belts, clothes, etc., that may wander too near for their good. Then, too, the spring acts as a check and will retain the screw should it loosen. It is just an idea that should be better known for the common good. WARREN E. WILLIS.

Philadelphia, Pa.

SOME POINTS ABOUT OILING—KEEPING A LINESHAFT CLEAN.

For oil holes which are clogged run a red-hot wire into them; this will cause the thick oil, etc., to thin out. Always hold the spout of the oiler a short distance above the oil-hole so you can see the oil dropping in; do not shove the spout down in the hole and take chances for very often you think the oil is getting in when in reality it is doing nothing of the sort.

If you, Mr. Foreman, want to keep your line shafting nice and bright, that is to say, free from dust, simply take two



pasteboard washers, hole to be slightly larger than shaft, and break through, as shown in Fig. 1, then slip over the shaft, two between each pair of hangers. You will see them travel back and forth as long as the shaft is in motion and in so doing they will remove every bit of dust. It is a cheap experiment and well worth trying.

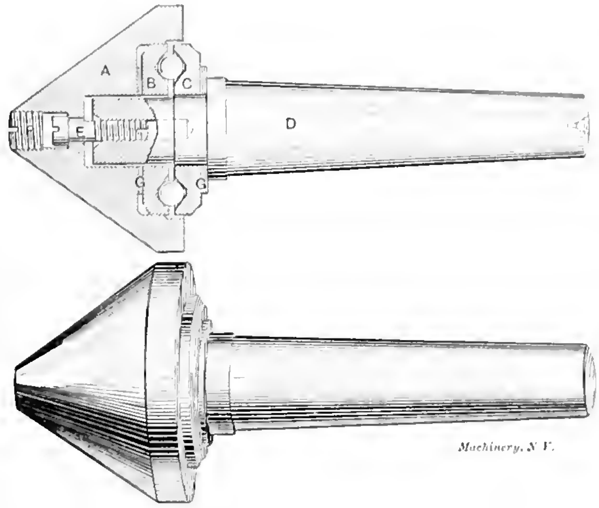
Fig. 2 shows the two travelers, *A*, that only stop to rest when the shop does. ROBERT A. LACHMANN.

Chicago, Ill.

PIPE CENTER.

The accompanying illustrations are sectional and outside views of a pipe center which is rapidly superseding centers similar to that described in the January issue of MACHINERY by J. T. The ball thrust bearing insures absence of slip,

thus reducing the cutting or wearing away of the center or the work when a hollow article is being turned. Referring to the sectional view, the ring or race B is firmly attached to the cone center A with which it revolves; the race C is affixed to the shank D, which of course is fitted to the spindle of the lathe footstock. The parts are held together by the



fillister-head screw E. Hard fiber washers are inserted at the back of the races to prevent a too harsh contact of the balls and the races. The screw F prevents the admission of dirt to the interior.

This center is made by Chas. Taylor, of Birmingham (Eng.), the well-known chuck and machine vise specialist.

Birmingham, Eng. FRANCIS W. SHAW.

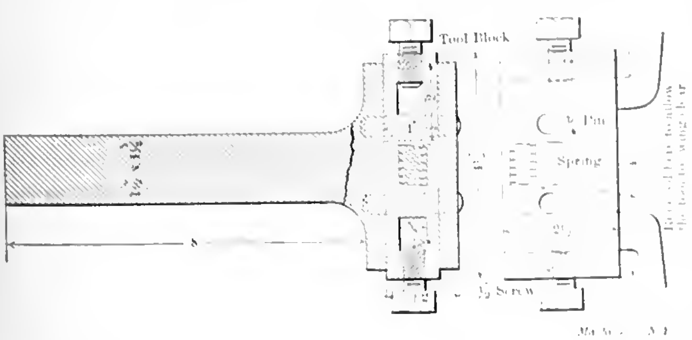
HANDY WATER CONNECTION FOR CAR WHEEL PRESS.

The following method of connecting water supply to a wheel press pump may be of interest. The city water pressure here is about 90 pounds; it is connected directly to the suctions of the pump with a ½-inch cut-out cock convenient to the attendant's hand. By simply opening the cock the ram is rapidly advanced to the end of the axle and all lost motion is taken up before starting the pump into action. When the axle is nearly out of the wheel the city water pressure on the ram is then sufficient to remove the axle much quicker than the pump could. This kink has been found very effective as applied to an old-style wheel press here. A. E. MITCHELL.

Malone, N. Y.

DOUBLE-HEAD TOOL FOR PLATE PLANERS.

I send you a sketch of a double-head tool for use on plate planers for planing surface work on structural or boiler plates; also on boiler patches, this enabling the planing to be done, each way of travel of head and doing the work in one-half the time. I recently visited a shop which had a plate planer some 18 feet long, on which a surface 6 or 8 inches

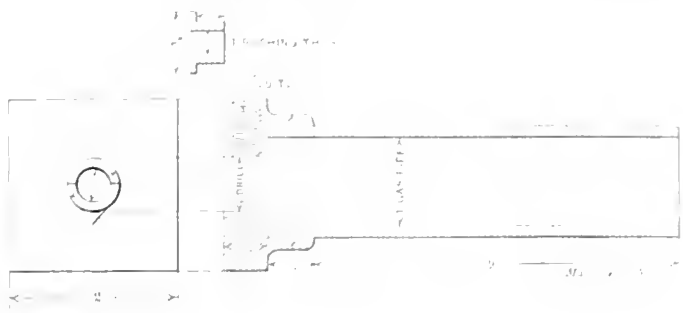


wide on a plate was being planed with a single tool, the tool being raised on the return stroke, thus losing one-half the capacity of the machine. I have seen the tools shown in cut in use for years and know it works well; it is certainly a timesaver on that class of work when used on plate planers.

TOOLMAKER.

HOLDER FOR GRINDING SQUARES ON SETSCREWS, ETC.

The cut shows a handy little device for grinding squares on small taps, reamers, setscrews, etc. The sides of the square part of the holder being large and resting on the emery wheel table a tap or any small round thing can be accurately

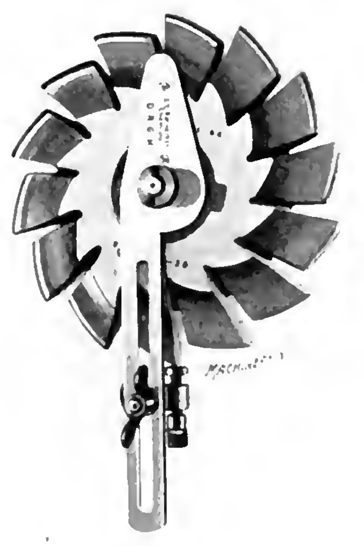


squared up in a jiffy. A half-bushing can be inserted for smaller sizes. Of course this holder could also be made for larger work but the large work would probably be machined anyway. ARTHUR MUNCH.

St. Paul, Minn.

MICROMETER GAGE FOR MILLING CUTTERS.

I send you a sketch of a gage now made by J. E. Reinecker, Chemnitz-Gablenz, Germany. It has the advantage over those formerly made by the same manufacturer, for testing cutters, that each tooth can be tested separately as regards its length measured from the center of the mandrel. This is a very good feature, as a non circular cutter very much reduces the capa-



city and quality of output of the milling machine; and further by reason of the unequal strain on the teeth, some of the longer ones are apt to break. The centering of the gage is effected by disks accurately fitting the cutter bore, entirely independently of the key slots. ROBERT GRIMSHAW

Hanover, Germany.

• • •

The senso which enables us to judge of the perpendicularity of objects is well developed in most persons, and is more or less reliable under ordinary conditions. There are conditions under which it is deceptive, as for instance, when a train is rounding a sharp curve the trees and buildings will appear to lean outward toward the observing passenger, if he is on the inside of the curve. The reason is that the elevation of the outer rail of the track, to compensate for the effect of centrifugal force, is usually such that at normal speed a plumb line suspended in the middle of the car would hang midway between the tracks, and of course the persons standing or sitting adapt themselves to the component of the vertical force of gravity, and the horizontal effect of the centrifugal force. Hence they refer all objects to their latent sense of erectness, thus making buildings and trees appear to stand out of plumb.

SHOP RECEIPTS AND FORMULAS.

Practical Tried Receipts—those known to be Good—are Solicited.

TO WRITE BLACK ON GLASS OR BRIGHT METAL.

To write black on glass or bright metal, use 1 to 2 parts of silicate of soda with 10 parts of India ink. Write with a steel pen.
F. H. JACKSON.

Angelica, N. Y.

MIXTURE FOR MAKING A POROUS CASTING AIR- AND WATER-TIGHT.

To make a porous casting air- and water-tight prepare a saturated solution of copper sulphate, mix with it an equal quantity of commercial nitric acid. Dip the casting into the solution, or pour it over the casting on all sides and let stand for a few hours.
L. S. BURBANK.

Worcester, Mass.

BLACKING BRASS.

For blacking brass I find nothing superior to chloride of antimony. The articles should be thoroughly cleaned and polished, then immersed in the solution for a short time, and dried over a spirit lamp; then brush with a black lead brush.

Angelica, N. Y.
F. H. JACKSON.

NON-RUSTING SOLDERING FLUID.

To make a non-rusting soldering fluid, dissolve small pieces of zinc in hydrochloric acid till effervescence ceases. After standing a day, take out the undissolved zinc, and filter the solution. Then mix with one-third its volume of C. P. ammonia, 26 degrees, Beaume, and dilute with water to suit the work to be soldered. This flux does first-class service and does not rust the work.
F. E. WHITTLESEY.

Corry, Pa.

STEEL HARDENING AND TEMPERING COMPOUND.

I would submit the following formula as an excellent compound for hardening and tempering steel. We have tempered flat cutters, Acme and U. S. standard taps, counterbores, reamers, etc., to our entire satisfaction, without drawing the temper in any of them: To 10 gallons of soft water, add 5 teacups salt, 6 ounces saltpeter, 12 teaspoonfuls of powdered alum, and 1 teaspoonful corrosive sublimate.
H. S. HINDMAN.

Columbus, O.

INSULATING COVERING FOR STEAM PIPES AND BOILERS

To one barrel of lime use six barrels of sawdust. Slack the lime in an ordinary mortar bed, and when slacked mix in the sawdust, using enough water to make it of the consistency of mortar. Apply when the steam is on. This covering is adapted for steam pipes and boilers, more especially in sawmills and other places where a box can be built around the pipe so as to hold the mixture in place. It is approved by insurance companies.
THEODORE DISCH.

Milwaukee, Wis.

PROCESS FOR PULVERIZING BORAX.

To a two-gallon pail of boiling water add as much borax as will dissolve, and a surprising amount will dissolve—12 to 15 pounds in two gallons of water. When as much borax is added to the boiling water as will dissolve, set the pail in cold water, running water preferred. Stir contents vigorously, which will in a few minutes form into a thick mass; spread this out thin on some smooth surface, as tin, where it will soon dry to flakes which, when handled, will crumble to dust. This process is employed here at the Rock Island arsenal.

Moline, Ill.
ALBERT D. KNAUEL.

ETCHING SOLUTION.

The etching solution made by the following formula has an advantage over other etching solutions in that it will not rust the most highly polished steel, and it is not in any way injurious to the hands or clothing—as a matter of fact the hands can be dipped into it with no ill effects. Mix 6 ounces distilled water; 4 ounces sulphate of copper; 4 ounces chloride of sodium (common salt); 1 dram sulphate of zinc; ½ dram sulphate of alum. The solution is applied in the following manner: The piece to be marked is covered with melted beeswax, and the inscription to be etched is marked through the wax with a fine pointed tool, leaving the wax undisturbed save where the marking is to appear. The markings are then filled with the fluid and allowed to stand for three hours. The result will be a very sharp and distinct lettering.

Philadelphia, Pa.
L. MEYERS.

TO PREPARE IRON OR BRASS FOR LAYING OUT WORK.

To coat the finished surface of iron and steel with a copper film to facilitate laying off work, make a solution of sulphate of copper and apply to the work with a piece of clean waste; the copper film shows up the lines very plainly. This solution can also be used on brass by simply sprinkling iron filings on the brass surface, and then applying the copper sulphate solution. The surface to be coated should in all cases be free from oil, grease, etc.
OLIVER E. VORIS.

Dayton, O.

TO HARDEN CAST IRON—TO KEEP WATER FROM FREEZING OR SOURING.

To harden cast iron take ½ pint vitriol (sulphuric acid), 1 peck common salt, ½ pound saltpeter, 2 pounds alum, ¼ pound prussiate potash, and ¼ pound cyanide potash, dissolve in 10 gallons of water. Heat iron to a cherry red, dip, repeating until hard enough.

To keep water in fire barrels from freezing or becoming sour, dissolve 1 peck common salt and a lump of unslacked lime, say about 8 inches diameter, in each barrel.

Harrisburg, Pa.
W. T. SEARS.

LUBRICATING SOAP FOR WIRE DRAWING, SCREW CUTTING AND WORKING METALS.

Put 20 pounds of pure caustic potash into an iron or earthen vessel with 2 gallons of water. The potash will dissolve very quickly by heating the water. Heat 9½ gallons of oil to about 140 degrees F., which is most easily done by bringing a small portion of the oil to the boiling point and adding this to the remainder. Pour the caustic potash lye into the oil in a small stream, stirring steadily with a wooden paddle until the oil and lye appear well combined and smooth, which will take only a few minutes. Put the mixture in a warm place, covering the vessel well with blankets or woolen rugs to keep in the heat caused by the mixture combining and turning into soap. This wrapping is very important, the object being to keep the temperature uniform until saponification is completed. The mixing may be done in a wooden vessel, half an oil barrel answering very well. After three or four days the soap is formed and may be used, though it is better, in order to insure perfect saponification of all the oil, to stir it up well again and leave standing, still well covered, for a few days longer. In this way the finest possible soap for lubricating purposes is made. It is a real potash soap made pure for use, not made cheap for sale by the addition of water and impurities, and, moreover, cannot be excelled for cleaning or washing purposes, especially for washing flannels, and will never cause sore hands.

Use a first-class pale seal oil for soft soap for wire drawing, though a good, refined cotton-seed oil may be used for general purposes. It is absolutely necessary that the caustic potash be unadulterated, for the principle of this cold process of making soap depends on the use of strong, pure lye of caustic potash.

The best way of making the suds with this soap is as follows: Put 6 pounds of the soap into a vessel with 2 gallons of hot steam water, heat to thoroughly dissolve the soap, stirring well, then add 6 more gallons of water and lastly 3 gallons of oil, which should be thoroughly stirred into the soap and water, so that on standing over-night the oil will not separate. This will be found to give very good results.

The cost of this soap depends on the quality of the oil and whether wholesale or retail prices are paid. Even at the latter it will not exceed 7 cents per pound. With cotton-seed oil and wholesale prices it can be made for about 5 cents, which would be equivalent to ordinary soft soap bought at 2½ cents per pound.
A. F. BIERBACH.

Milwaukee, Wis.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

37. A. L. K.—Suppose I make an end gage of ¼-inch tool steel drill-rod to exactly fit a cast steel locomotive driving wheel bore 10 inches diameter, and do the job out of doors with the temperature at the freezing point, being careful that the temperature of the drill rod falls to that of the wheel. When brought into the shop such a gage expands about 0.002 inch in length. Will it be safe to turn the axle to the end-gage size, making the usual allowance, of course, for a press fit? In other words, will the drill-rod and wheel center expand and contract with changes of temperature at the same rate?

A.—If you make sure that the drill-rod gage is no warmer than the wheel center when the fitting is finished there should be no trouble in using such a gage for getting the size of the axle fit. It is true that cast steel and tool steel do not change exactly the same for variations in temperature, but the difference is small, the coefficients being about 0.00000636 and 0.00000689 for cast and tool steel respectively. This would mean a difference in expansion in a rise of 30 degrees F. of about 0.00015 inch for 10 inches. These figures are not exact as various authorities do not agree on the coefficients for various metals, but the result given above is not far out of the way.

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38. Inquirer.—What are the proper proportions for a cast-iron spring piston ring of unequal thickness, that is, of the eccentric type, and the proper amount to be cut out of the thinnest point, in order that a tight joint may be made when the ring is sprung over the piston?

A.—This problem is worked out in Unwin's Machine Design, where for uniform pressure on the surface of the cylinder a ring is arrived at which varies uniformly from a thickness at the thickest point of $t = 0.04$ to $0.06r$, where r is the radius of the ring when sprung into the cylinder, to nothing at the ends, opposite the thickest point. The outside radius of the ring initially is $1.1r$; about 2-3 of the inside curve of the ring agrees very closely with a circle struck off from a point distant $0.206t$ from the center of the outside of the ring. The ring is accordingly bored out eccentrically to a radius $r - 0.794t$ and the points near the thinnest part of the ring are still further thinned out. While theoretically correct, this construction will not do in practice, because the thin part of the ring wears away the groove in the piston. Prof. John E. Sweet, of the Straight Line Engine Co., Syracuse, N. Y., informs us that the practice of the latter company is to make snap rings practically 1-48 larger than the cylinders, so that the ring for a 9-inch piston is turned 3-16 inch larger than the cylinder and bored eccentric so as to leave the rings from ¼ to 5-16 inch thick at the thick part, and ¾ that thickness at the ends. If a tight joint is to be made when the ring is sprung over the piston the amount to be cut out would be in the case of the ring for the 9-inch piston above mentioned $9\ 3\text{-}16\ \pi - 9\pi = 0.589$ inch.

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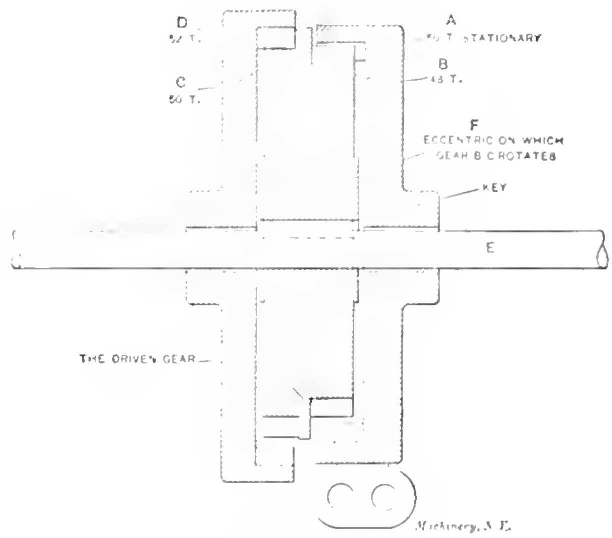
39. F. J. C.—I am making a model epicyclic gear of the form shown in the cut which is said to give a speed reduction of 625 to 1. Gear A is stationary and will have 50 teeth; B and C are cast together and turn as one, B having 48 teeth and C 50 teeth; D is the driven gear and has 52 teeth. The gear BC is mounted on an eccentric, F, keyed on the shaft, E. I wish to make a gear that will give a velocity ratio of 644 to 1; what are the rules for calculating the speed reduction, and for finding the numbers of teeth of the gears that will give a desired ratio?

A.—There are several methods of solving problems in epicyclic gearing, but the one given herewith is, perhaps, most frequently used in applied mechanics as it is simple and requires less mental gymnastics than the others. We first consider the shaft, E, as being stationary and gear A turned around once in a right-hand or + direction. The velocity ratio of the driven gear, D, and the intermediate gear, BC, is found, of course, the same as for any simple train of gearing, and is that given in the first line of the table. Since all the gears turn in the same direction the ratios all have the + sign. Now if we lock all the gears together and turn shaft E in a left-hand or — direction one turn, it is apparent that all the gears are given one turn backward since they turn with the shaft, hence the second line of the table:

	A	B and C	D	E
Shaft E stationary and gear A rotated one turn.	$+1$	$+\frac{50}{48}$	$+\left(\frac{50}{48} \times \frac{50}{52}\right)$	0
All gears locked together and rotated around common center one turn.	-1	-1	-1	-1
Algebraic sum	0	$+\frac{2}{48}$	$+\frac{4}{2496} = \frac{1}{624}$	-1

From the above it will be seen that gear D turns 1-624 revolution to one turn of shaft E, and in an opposite direction since the signs are opposite. Hence the velocity ratio is 624 to 1



Epicyclic Gear Train

instead of 625 to 1 as you state. The ratio 644 to 1 may be obtained with gears 60, 56, 43 and 46, instead of gears 50, 48, 50 and 52, but arranged in the same order. We know of no rule for finding the gears of an epicyclic train which shall give a required ratio; they must be found by a process of selection, keeping in mind desired relations of gears, numbers of teeth, etc. See MACHINERY, September, 1900, page 25.

* * *

ALLEGED METHOD FOR BALANCING BALLS!

In a fearful and wonderful article on ball bearings of automobiles published in an automobile paper some months ago, a writer who should be well known because of the fake mechanical stuff which he has palmed off on unsuspecting editors of trade and other class papers tells of some astonishing failings of this type of bearing, and gives equally astonishing methods of repair. No one else would have dreamed that ball bearings had the vicious, depraved habits attributed to them by this writer; neither could they, we venture to say, have imagined the methods of repair he has devised for them. As an instance of his mechanical prowess, we reproduce his

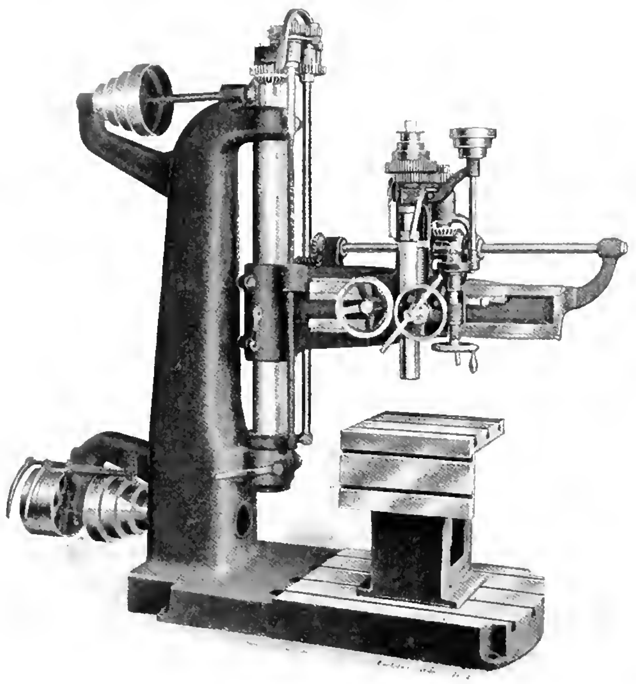
method of ascertaining whether steel balls are in balance. Any mechanic will at once perceive the depth of this gentleman's knowledge. He says that a plan for testing balls for proper balance is shown in the cut. The scheme consists in using the two points, A A, which points are part of the tool system of a gage. They are fixed in shouldered hubs in which there are blocking threads (whatever that may mean), and by these threads the stubs can be set to prick the balls in their centers and hold the ball in place while it is revolved to ascertain where the ball is out of balance, if at all out of balance. Defects located can be rectified. Very defective balls are thrown out! If there is anything worse than this on record, we have yet to see it.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

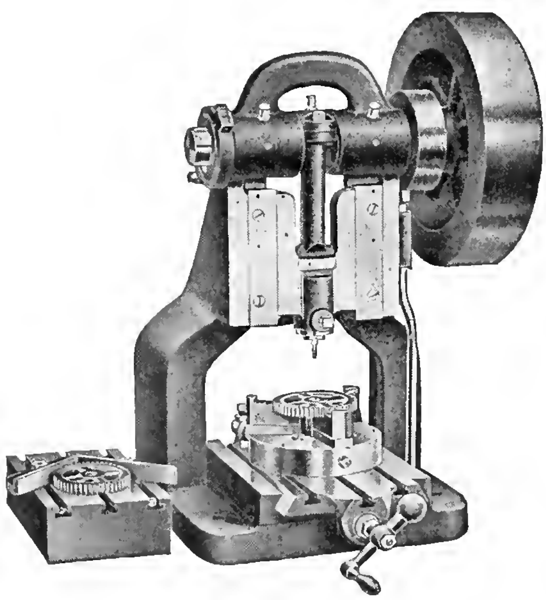
IMPROVED PLAIN RADIAL DRILL.

The half-tone given below illustrates an improved plain radial drill manufactured by Roos & Mill, Cincinnati, O. Simplicity and sufficient rigidity for the use of high-speed tool steels have been the chief ideas in the design of this tool. The main column is cast in one piece with the base, and supports at the top and bottom a heavy secondary column on which the



Plain Radial Drill.

arm is mounted. The arm has a box girder shaped cross section and numerous inside ribs. It is elevated and lowered by power and easily locked to the column. The spindle has eight changes of speed, hand and power feed, automatic and safety trip, and a quick-return movement. The drill is arranged for tapping, the mechanism therefor being located on the head at the back of the arm, and operated by a handle near the lower



Keyseating Punch.

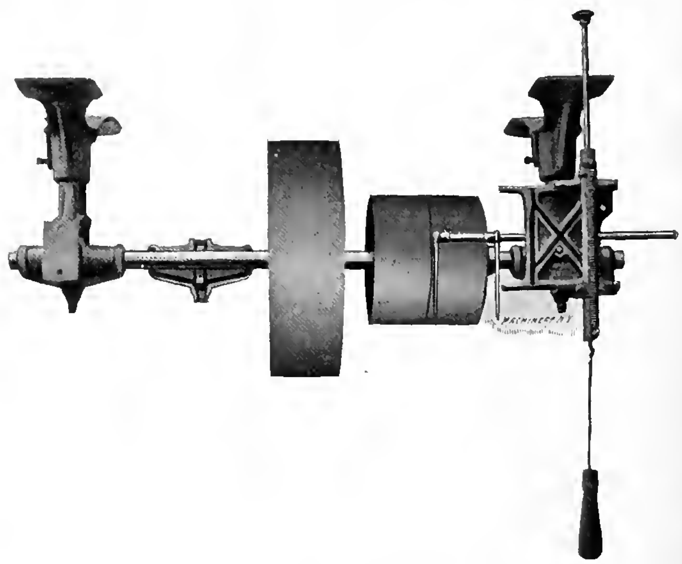
end of the spindle. It is fitted with adjustable friction clutches which will draw tight proportionally to the power required. The back gears and high-speed gears engage directly with the spindle, thus relieving shafts, gears, and couplers from heavy strain. The main column in the 3-foot radial drill is 15½ inches square at the bottom. The arm-column is 5½ inches in diameter, and the arm has maximum vertical range of 2 feet 7 inches. The spindle has a horizontal range of 2 feet 6 inches, and a vertical range of 12 inches. Its smallest diameter is 1 11-16 inches and its largest 3 inches. It is, in the 3-foot radial drill, bored to fit a No. 4 Morse taper. The machine receives work 4 feet 6 inches high under the spindle and over the base, and the drill works on the base to center of 7 feet 10 inches, and over table to center of 6 feet.

KEYSEATING PUNCH.

The keyseating punch illustrated below is designed for light internal keyseating, cutting keyways from ⅛ inch up to ⅜ inch wide. The sliding table is operated by a ball handle and screw. The table has three ½-inch T-slots, and is furnished with or without a chuck for holding work. The subtable, as shown, has three ½-inch T-slots and a V-block. The over-all height of the punch is 28 inches, and the length of stroke 1½ inches. The size of the sliding table is 5¾ by 11¾ inches and its longitudinal movement is 2½ inches. It is made by the B. F. Barnes Co., Rockford, Ill., who first built it for their own use in cutting keyways in small gears, etc., some two years ago. It is now placed on the market for the first time.

A ONE-PULL POSITIVE LOCK BELT SHIFTER.

The Diamond Clamp and Flask Company, Richmond, Ind., have gotten out a belt-shifting device, here illustrated, by which a machine run from the fast and loose pulleys on the countershaft may be started by simply pulling the cord shown, and then stopped when desired by pulling the cord again. The



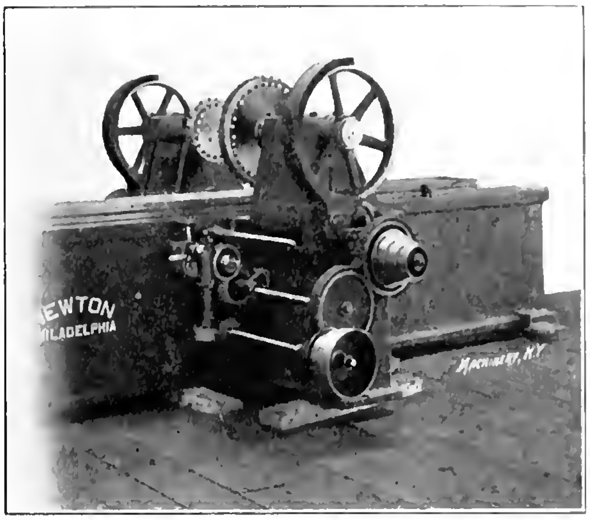
Positive Lock Belt Shifter.

shifter locks itself in position either way. The chief feature of the device is the shifting plate which carries the shifter fingers, and which, as shown, has two vertical grooves on its face, and two diagonal grooves that intersect the vertical grooves toward the top and bottom of the plate. The frame consists of one piece having two half-round guide ways on the ends for the shifter plate, and also guide ways at right angles to these for the pull rod. The bottom is slotted so as to be bolted to a hanger or other convenient support. Swiveled in the pull rod is a diamond-shaped nut, which is held normally at the top of one of the vertical grooves in the shifter plate by a tension spring. By pulling the cord of the pull rod the nut follows down the vertical groove until it strikes the offset of the groove at the bottom of the plate, which switches it off into the intersecting diagonal groove. The shifter plate is moved forward when, on releasing the cord, the diamond-shaped nut is returned to the top of the plate by the tension of the spring, the nut being guided by the diagonal groove, thus shifting the belt onto the other pulley. The nut

is now held in position at the top of the second vertical groove by the spring, ready to reverse the motion by means of the other diagonal groove upon the next pull of the cord. A special plate is of course required for each width of belt, so that each frame is provided with shifter plates that can be substituted for any width of belt desired. The countershaft has universal adjustable hangers, and carries a swivel box with ring oiling device.

SPECIAL DUPLEX MILLING MACHINE.

The illustration shows a duplex miller specially designed by the Newton Machine Tool Works, Philadelphia, for milling grate bars for mechanical stokers, the large cutter milling the flange side of the bar, and the smaller cutter recessing out the opposite side. The large cutter head is 20 inches in diameter,



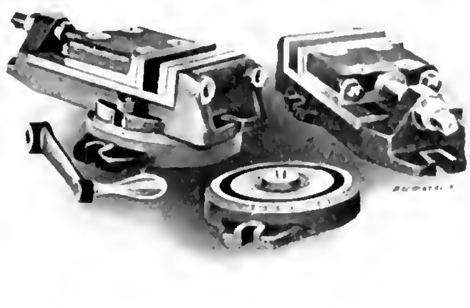
Duplex Milling Machine.

and the smaller one 12 inches; these cutter heads are fitted to spindles 4 inches in diameter, and are driven through gearing by a 4-inch belt, operating through tight and loose pulleys, the gearing being so arranged that the peripheral speed of the cutter heads is equal. The carriage is 12 inches wide and 13 feet 3 inches long, to mill work 12 feet long.

The carriage is operated by a screw and has four changes of automatic feed and power quick traverse, the automatic feed to the table being controlled through stops. The cutter heads are arranged to give a maximum distance of 12 inches between the tools, each head having 1 inch of adjustment. The spindle head for the smaller cutter is arranged to have an automatic in-and-out movement operated through stops, so that the head can be fed into the cut or withdrawn from it at any position.

NEW MILLING MACHINE VISE.

The Becker-Brainard Milling Machine Company, Hyde Park, Mass., are making a new model vise in sizes having jaws from 5 inches to 8 inches wide. It may be used as a plain milling machine vise, or when mounted on the rotary base, as a rotary

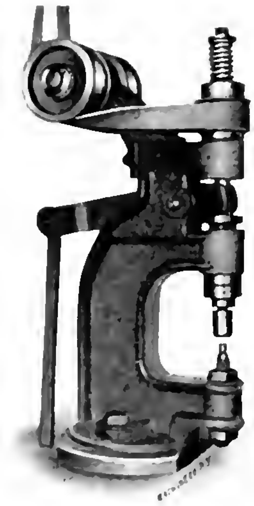


Milling Machine Vise.

vise. The rotary base is graduated for fine adjustment. To mount the vise upon this base it is merely necessary to insert two bolts. All parts are machined in fixtures and jigs, and are hence perfectly interchangeable. Strength is especially provided at the face of the lower jaw by the distribution of the metal and the strong ribs on the under side. It is particularly made for use with milling machines, but is also adapted to be used with drill presses, planers, etc.

GRANT RIVET SPINNING MACHINE.

The machine shown in the accompanying cut is designed for spinning heads on the shanks of rivets, as distinguished from forming the heads by blows of a hammer or machine. The part to be riveted is placed head down on the anvil of the machine, when pressure on the foot treadle forces the rapidly revolving spindle downward, causing the spinning rolls, which are formed for the shape desired, to spin a head on the shank of the rivet. The spinning rolls are made in halves, each the counterpart of the other, and are interchangeable in the roll holder. Heads may be rolled of a conical, or of a full half-round shape, or with an arc of a circle of any dimension.



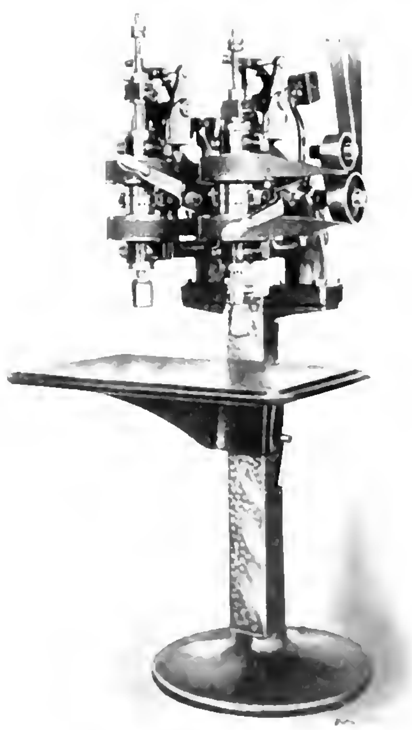
Grant Rivet Spinning Machine

The finished head is smooth, and as there is no upsetting action, shoulder rivets or rivets closely fitting holes in parts to be riveted may be securely headed without danger of binding the parts when a flexible joint is required, as is often the case in typewriters, adding machines and other mechanisms.

The capacity of the machine is for $\frac{1}{4}$-inch rivet shanks and smaller. The distance from the back of the throat to the center of the rolls is 4 inches, the adjustment of the anvil $1\frac{1}{4}$ inches, the width of the belt $1\frac{1}{4}$ inches, and the bench space required is 10 inches wide by 15 inches deep, by 23 inches high. The machine is made by the Grant Mfg. & Machine Co., Bridgeport, Conn.

DUPLEX VERTICAL TAPPING MACHINE.

The Grant Mfg. & Machine Co. have also brought out a duplex vertical, automatic, tapping machine designed to meet the special requirements found in typewriters, adding machines and similar work, the table being of such proportions as to provide ample bearing surface for large frames.



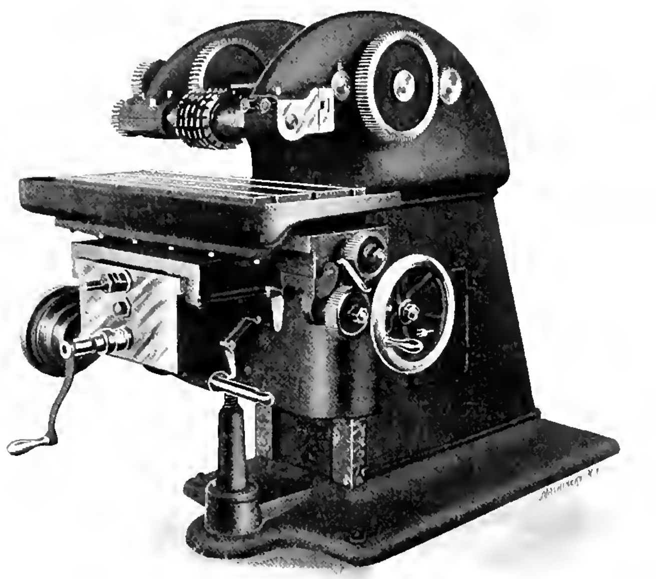
Duplex Vertical Tapping Machine

The distinctive novelty of this machine is the engaging of the forward driving friction by an upward movement of the operating lever. In most similar machines the engagement is made by a downward motion of the lever, which necessitates care to prevent the tap from diving into the hole. Another

distinctive feature is that the height of the spindles in relation to the table may be staggered, which is of value on work where the holes are on different planes, thus doing away with the necessity of blocking up work to place it in correct position with a spindle. This feature gives the machine increased capacity, holes being tapped from 1/8 inch to ½ inch. The table is 16x26 inches; the distance from center to center of the spindles 10 inches, and the distance from the chuck to the table when down, 26 inches; the distance from the face of the column to the center of the spindle is 10 inches. A 2-inch belt is used and the floor space required is 30 by 36 inches. These machines are also made with any number of spindles required.

WALCOTT RACK CUTTING MACHINE.

The rack cutter shown in the accompanying cut is a recent design made by George D. Walcott & Son, Jackson, Mich., to meet the demands of rapid work in using high-speed steels. This machine cuts racks 32 inches long and 8 inches wide, three-pitch or finer, without resetting the work. It is intended



Half Automatic Rack Cutter.

to take cutters 6 inches in diameter with 1¾-inch holes, but the same machine is furnished with cutter arbor, boxes and gearing so changed as to admit of the use of Brown & Sharpe standard cutters, as used on their No. 4 and No. 5 automatic gear cutters. The various parts of the machine are heavy, the top housing being 2 inches thick; the bearings for knee, cross rail, and table are all of the square lock pattern, and are wide and strong. The table is 14 inches wide and 33 inches long.

The driving mechanism consists of a train of seven gears and pinions, giving a ratio of 23½ to 1, driven by a 4½-inch belt running on a three-step cone between the housings. The pinions on the cutter arbor, intermediate, and first intermediate shaft are of steel; all bearings are bushed, those of the cutter arbor being provided with special bronze.

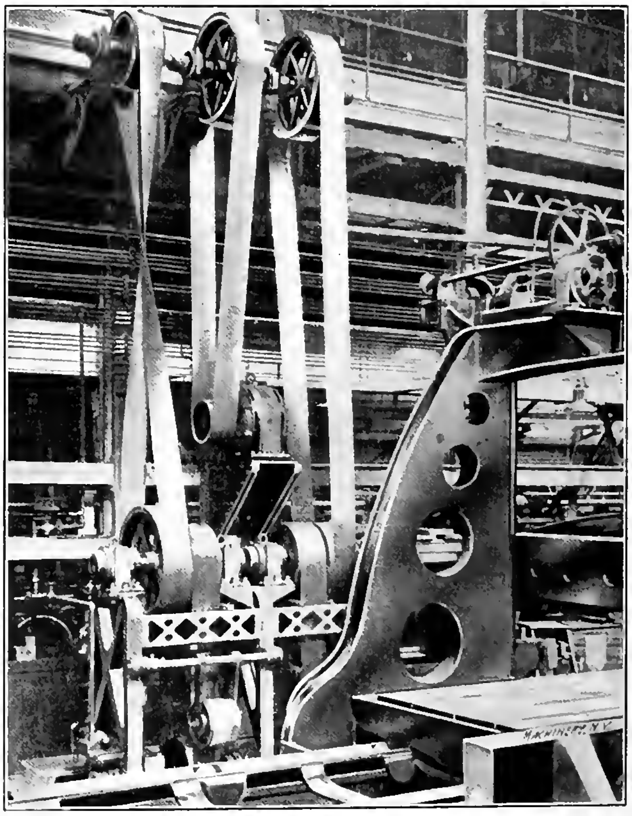
Changing the cutters is done by loosening the two bolts in the T-slot and sliding the bearing out endwise, when the cutter clamping nut may be removed and the cutters changed. Indexing is done by means of the handwheel and locking device shown immediately behind the handwheel, the only gear changed for the various pitches being that on the lead-screw. Two or more finishing cutters with two or more roughing cutters on either side are used so that the work may be changed and the table indexed in the opposite direction without traversing the entire length of the table for a new setting.

The feed shaft is carried in swivel bearings, the one on the right-hand side of the machine being held up by the latch when the worm is engaged. Four feeds, of .087, .125, .187 and .262 inch per revolution of cutter, are provided by four-step cones and belt on the left-hand side of the machine, the lower cone being on the end of the feed shaft. The feed cones are connected by an adjustable belt tightener, which maintains a constant tension on the belt for all positions of the table. The upper feed cone is carried on a swiveling yoke, and is driven by spur gearing from the pulley shaft. The elevating screw is provided with an index reading to thousandths for setting the depth of cut. The machine is so constructed that it may be run in either direction to accommodate special work, the automatic trip for throwing out the feed on completion of the cut operating in either case.

The cutter speeds for ordinary tool steel are 20, 30 and 40 revolutions per minute. With high-speed steel 32, 46 and 66 revolutions are intended to be made. The countershaft is run at 300 R. P. M. for ordinary cutters, and 415 revolutions for high-speed steel.

A MITCHELL PLANER DRIVE AT THE WESTINGHOUSE WORKS.

A Mitchell planer drive, the first of its kind installed in the United States, is shown in the accompanying cut as used in the works of the Westinghouse Electric & Mfg. Co. at East Pittsburg, Pa. The drive operates as follows: Two independent countershafts are supported on a framework attached direct to the planer. These countershafts may be either belt driven, as in this installation, or gear driven. From the forward and reversing pulleys on these countershafts, belts hang loosely over the pulleys on the main driving shaft. Idler pulleys, pivotally supported, may be actuated by the table, to press against the loose side of either of these belts, and so bring that belt in contact with a main driving shaft pulley. The idlers may be operated either by air or direct from the planer table. In the illustration herewith the operation is by air, levers actuated by the table dogs operating the air valve seen in the lower left-hand corner of the cut, so as to admit air to either side of a plunger, which accordingly swings the idler pulleys in the proper directions for forward or back driving.



Mitchell Planer Drive.

By this method the jar may be greatly reduced. The drive may be attached to existing planers, increasing their speeds from two to three times. It can be designed for variable cutting speeds, and any width of belt desired may be used. The drive here shown is run by a constant-speed Westinghouse motor of 40 H. P., running at 720 R.P.M. The representative of the device in this country is A. Burchard, 321 Savannah Ave., Wilkinsburg, Pa.

AN OSCILLATING MILLING MACHINE.

The accompanying illustrations show an oscillating milling machine which the Hendey Machine Co., Torrington, Conn., are introducing. It is intended to be used on work which in most cases presents points for finishing that are difficult to reach with the tools of the ordinary milling machine, shaper or slotter. The miller may be advantageously used for plain slotting, and for such operations as the facing off of the inner sides of bosses which would be awkward for a bar with a facing cutter and difficult for an ordinary slotter.

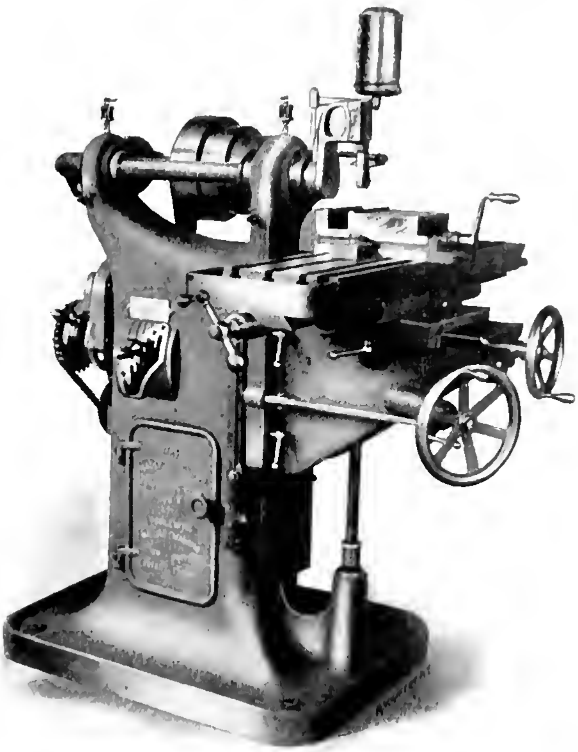


Fig. 1. Oscillating Milling Machine. Adaptation of Regular Milling Machine Design.

The principle on which the machine operates is a very interesting and, as far as we know, an entirely novel one.

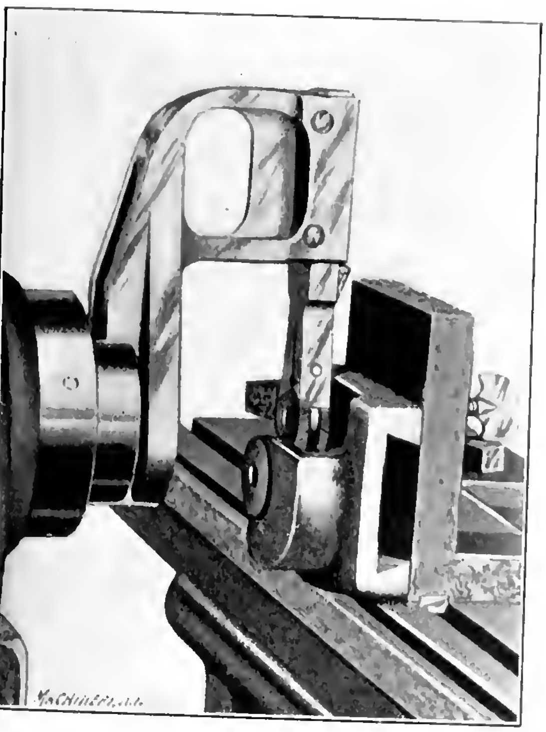


Fig. 3. Oscillating Miller Facing the Bosses of a Casting

Fig. 1 shows an adaptation of the design of the makers' regular milling machines, while Fig. 2 is a design especially made for the oscillating miller. The machine consists essentially of a driving shaft carrying on its rear end a movable wrist plate and pin, which is connected to the main spindle of the machine by means of a hollow connecting rod. This connecting rod is attached to a yoke on the main spindle at the back of the machine, so that the rotation of the driving shaft imparts an oscillating motion to the main spindle, the amount of this oscillation being regulated by the movable wrist plate and pin. The cutter head may be either a part of the main spindle, as in Fig. 2, or a separate fixture, as in Fig. 1, in which case it is centered and held in place by a drawing-in bolt. The cutter is made with a suitable shank which is dovetailed to the cutter head, and is of such length that the axis of the cutter is in true alignment with the axis of the main spindle; hence the oscillating motion of the head leaves the axis of the cutter fixed in position, the cutter being given a partial forward and back rotation about it as though its axis were a real arbor. The cutter is always in contact with its work regardless of the direction of stroke, hence the teeth of the cutter are milled radially from the center with no clearance in either direction, and may be of V-shape or a flat form of tooth which may be ground across its face, giving it a double cutting edge, this latter form being preferred for cutters of large diameter.

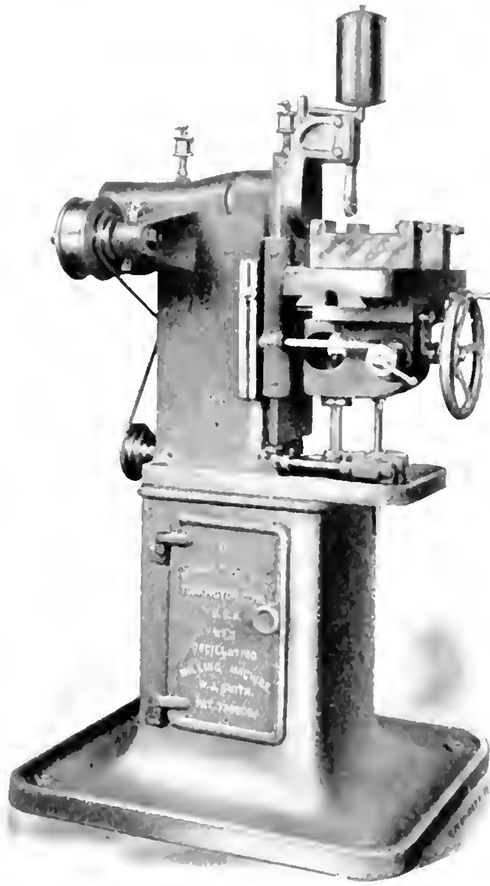


Fig. 2. Milling Machine Specially Designed to Operate on the Oscillating Principle.

Fig. 3 shows an oscillating miller facing the bosses of a tool post casting; the average time for chucking the work and finishing both sides of the boss of this piece was $4\frac{1}{2}$ minutes. Fig. 4 is an example of the milling of a semi-circular groove. All slotting work on the oscillating machine, as the tool post work mentioned, must first be drilled out by a jig to remove the stock, since as the cutter does not revolve and so clear itself, it is not intended to work down into the solid material. The relatively high speed of the cutter permits a proportionately fine feed, thus lengthening the life of the cutter. With each machine one cutter is furnished, and one special head fixture for use in indexing heads from which new cutters may be milled. These machines are now made in three sizes, the one shown in Fig. 1 having a table $36\frac{1}{2}$ by $10\frac{3}{4}$ inches working surface, and feeds all automatic, $25\frac{1}{2}$ by $5\frac{3}{4}$ by 17 inches. The machine shown in Fig. 2 has feeds, the vertical being automatic, $7\frac{1}{2}$ by 3 by 8 inches, and a table 18 by 8 inches working surface.

A TWENTY-FOUR INCH BACK-GEARED CRANK SHAPER.

The Queen City Machine Tool Co., Cincinnati, O., have introduced a 24-inch, back-geared crank shaper which is here

illustrated. The design is rigid and powerful, and as the ratio of back gearing is 29 to 1, full benefit may be got out of high-speed steels.

The 16-inch crank shaper of this company was illustrated and described in MACHINERY for October, 1904, and all the novel features of this tool are embodied in the 24-inch design. In both machines the crank is connected to the ram by means of a rocker arm and link, so that the forward cutting stroke

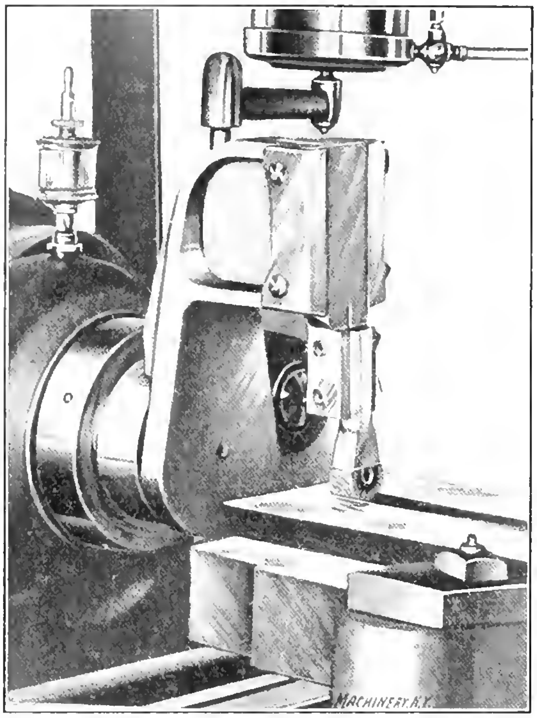
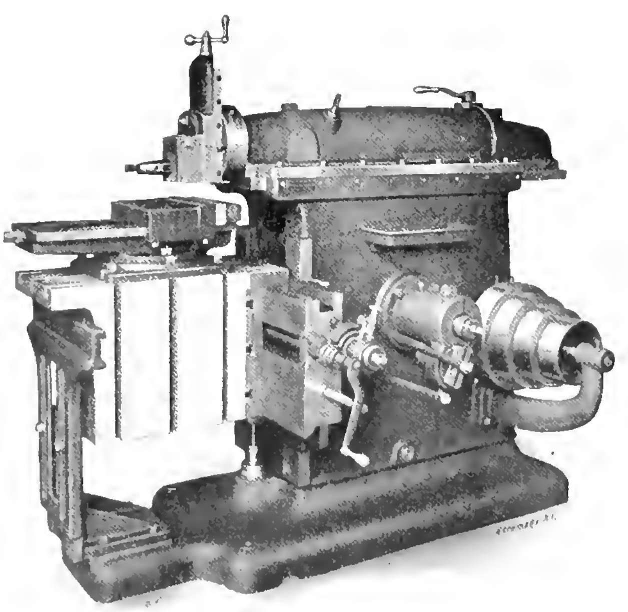


Fig. 4. Oscillating Milling Machine milling a Semi-circular Groove.

is a pull by the crank rather than a push; the ram is so arched as to bring the maximum section of metal into service when the cutting tool is in its extreme forward position. In the description of the 16-inch machine before mentioned, the details of ram, rocker arm, and back gears were illustrated.

In the 24-inch shaper the bearing for the ram is 40x11 inches, and the ways for the ram overhang, especially in

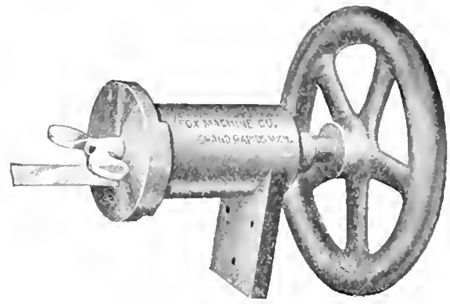


A 24-inch Back-geared Crank Shaper.

front. The rail has a 9-inch front and 1¾-inch top wearing surfaces. The cross traverse is 30 inches and the screw has a graduated collar. A cam at this point provides for a rapid changing of feeds from 0 to the extreme without stopping the machine. A telescopic elevating screw is used. The table is box form, T-slotted on top and sides has a V for holding shafts and similar work vertically; the outer support for the extension table is furnished on all 24-inch machines. The vise, of the planer type, has a base that can be firmly bolted to the table, and the swivel is held to this base by two steel planer head bolts. The head swivel is held in the same manner and both are graduated. The down feed screw to the head is provided with a graduated collar. A large opening under the ram provides for keyseating shafts or similar work, and has keyseating capacity up to 3¾ inches. The table has a vertical traverse of 15 inches and a cross traverse of 30 inches. The ram has 8 speeds; the feed to the head is 7½ inches.

WAX FILLET PRESS.

The fillet press here illustrated, manufactured by the Fox Machine Co., 815-825 N. Front St., Grand Rapids, Mich., is designed for use in the foundry and pattern shop, for conveniently running out wax fillets and wax core vents of different sizes. These are obtained as desired by turning the dial plate so as to bring the hole of proper size in front of the opening



Wax Fillet Press.

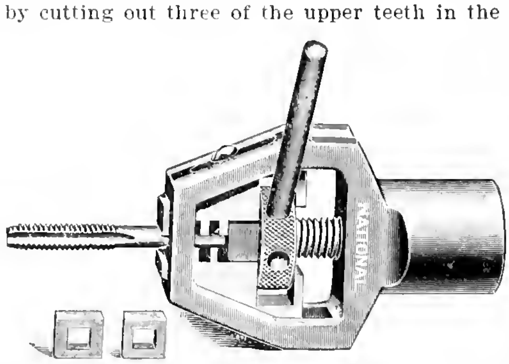
in the cylinder cap. The dial is located inside the cap casting, and may be readily turned by means of the thumbscrew shown. The cap is easily removed for filling the cylinder with wax. The supporting arm of the press is held in a vise when in use.

The press is regularly furnished with one dial for three sizes of core vents, 1-16 inch, 7-64 inch, and 11-64 inch, respectively, also fillets as follows: No. 2, fillet ⅛ inch wide; No. 3, 3-16 inch; No. 4, ¼ inch; No. 6, ⅜ inch, and No. 8, ½ inch wide.

Extra dial plates may be supplied with openings for any sizes of fillets or core vents desired. The press is furnished with a comparatively small handwheel for forcing out the wax. A large wheel may also be furnished if desired for use in cold weather, when the wax becomes so hard that considerable pressure is required; but it is considered better practice to slightly warm the cylinder of the press at such times by holding the press over a gas burner or lamp flame for a few moments, in which case the wax will run out in better shape and a small wheel will then be ample.

POSITIVE CHUCK FOR HOLDING TAPS.

The Oneida National Chuck Co., of Oneida, N. Y., have recently made an adaptation of their drill chuck for the holding of taps positively when tapping or reversing. This is accomplished by cutting out three of the upper teeth in the jaws of



Positive Chuck for Taps.

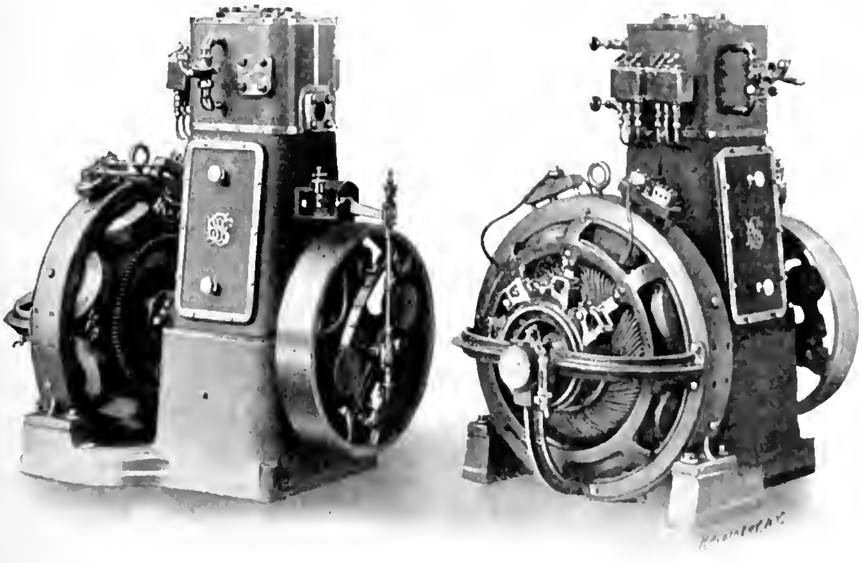
the chuck so as to admit a square block with a square hole into which the square end of the tap is placed; the jaws are then run down upon the tap, the remaining teeth of the jaws gripping the shank, while at the same time the flat part of the jaw grips the side of the square block, thereby holding the tap positively in either direction. The chucks are furnished with a sufficient number of blocks to hold each size of drill up to their full capacity.

A NEW STURTEVANT GENERATING SET.

The B. F. Sturtevant Co., Boston, Mass., have brought out a generating set of a type especially suitable for modern yachts and similar service. It was built originally for the use of the United States government and in accordance with specifications of the Bureau of Equipment.

The engine is of the high-speed reciprocating type designed to run at 650 revolutions per minute. The cylinder, which is cast with the frame, is 4½ inches diameter and 4½ inches stroke. The valve is of the balanced piston type and is operated by a Shepherd governor attached to the flywheel. This governor secures quick action and regulation within 1½ per cent from full load to no load. The piston is secured to the rod by a taper fit; the crosshead, which is of the slipper type with forked-end connecting rod, has a pin 1½ inches in diameter by 1¾ inches long, while the crankpin is 2 inches in diameter by 2½ inches long, and the main bearing is 1 15-16 inches in diameter by 6 inches long. The entire engine is enclosed by a cast-iron frame suitably lagged.

The generator is of the 8-pole type, designed for the continuous output of 5 K.W. at 650 R.P.M. It is capable of carrying for short periods of time 50 per cent overload without shifting of brushes or flashing at the commutator, and is capable of continuous operation at 25 per cent overload without sparking or undue heat. The increase in temperature above that of the surrounding atmosphere will not exceed 40 degrees C. in any of its parts after a continuous run of 10 hours at full load. The insulation resistance is such that it will withstand a breakdown test of 1,500 volts for a period of one minute, and will show a resistance of at least one megohm with an initial voltage of 500.

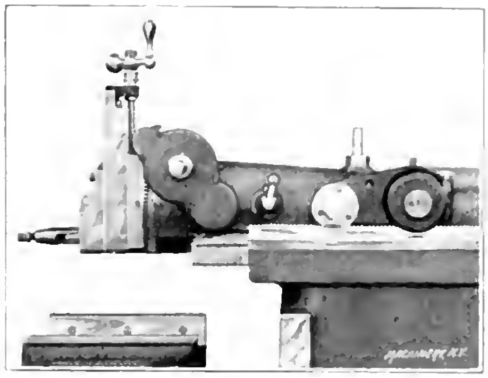


A Sturtevant Generating Set

The magnet frame is of cast iron, to which are attached by through bolts the pole pieces of wrought iron with cast-iron shoes. Each pole piece is energized by its own field coils, which are easily removable. The armature is of the iron-clad, two-circuit, form-wound, ventilated drum type, having a core of special low-carbon steel mounted upon a cast-iron spider, which has a hub extension for the support of the commutator. The commutator consists of bars of drawn copper secured in a cast-iron shell of spider construction and clamped with a steel ring. The end insulation consists of micanite rings, and that between the segments is of the best quality mica. The brushes are mounted upon studs which project from a brush rigging attached directly to the magnet frame, and this is so arranged that it may be rotated for adjusting the position of the brushes. The brush holders are of the sliding socket shunt type, each brush being supplied with a flexible connection and having a carrying capacity not exceeding 30 amperes per square inch. The brushes and holders may each be separately adjusted, and are readily removable. The total weight of the set, including the engine, generator, and sub-base, is 1,140 pounds.

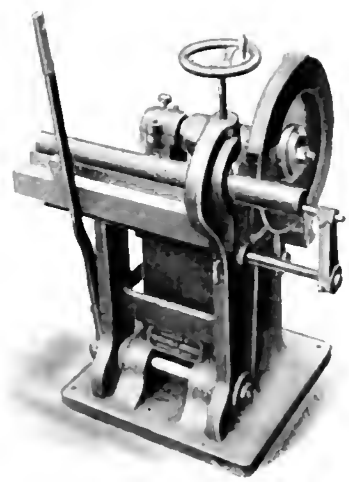
AUTOMATIC FEED FOR CRANK SHAPER.

We illustrate herewith an automatic down, angular, and circular feed for a shaper head which the Springfield Machine Tool Co., Springfield, O., have designed, as applied in this instance to their 16-inch back-geared crank shaper. The movement is from the rack, as shown, through a pawl and ratchet and train of gears to the elevating screw, for down and angu-



Shaper Head with Automatic Down and Circular Feed

lar, and through a worm and the worm wheel shown, for the circular feed. By the pawl, which is similar to those used on planers, the feed is thrown in or out or reversed. The small lever on the side of the ram between the pawl and gear case to the left of the machine is so arranged that by throwing it from one side to the other the vertical and angular feed will be engaged and the rotary feed disengaged, and *vice versa*. With



A Hot Saw for Drop Forgings

this lever it is impossible for the circular and vertical feeds to both be engaged at the same time. The small knob shown on the top of the gear case to the extreme right of the illustration is connected with a worm engaging with a worm wheel. This worm wheel has a segmental slot in which two stops are located, one stop being fixed to the friction, the other to the case, which is stationary. By revolving the knob either to the right or the left, the distance between the fixed stop on the case and the movable stop on the friction will either be lengthened or shortened, thus reducing the amount of rotation of the case carrying the feed pawl. A feed variation is thereby formed of from 1 tooth to 24 teeth per stroke. The working parts of the device are all on the right side of the machine. The gears are all thoroughly protected and covered with gear guards and the design presents a very neat appearance.

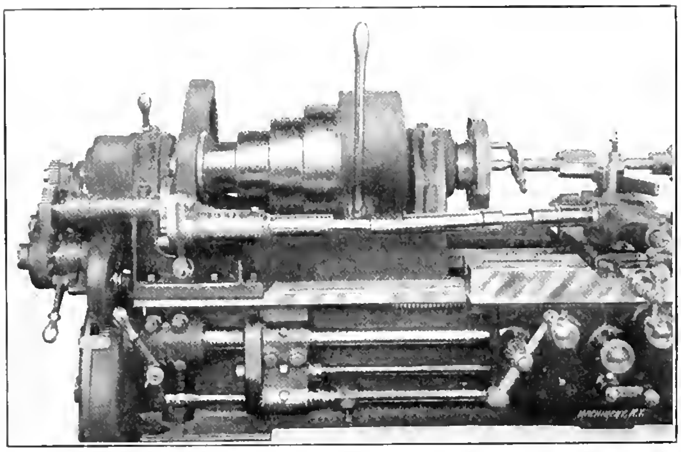
HOT SAW FOR DROP FORGINGS.

The Billings & Spencer Co., Hartford, Conn., have gotten out a hot saw for the rapid cutting of bar stock and the ends of such forgings as crankshafts, spindles, axles, etc. The saw is shown in the accompanying cut which is self-explanatory.

The saw cuts either hot or cold, but a considerable saving of time may be effected in the case of forgings by cutting hot, thus doing away with the necessity for several handlings. The saw is 20 inches in diameter by ¼-inch in thickness, and has a capacity of 3 inches round iron or soft steel. It takes a 4-inch belt, and is meant to run at 1,900 revolutions.

LATHE RELIEVING ATTACHMENT.

Below is shown a relieving attachment designed by the Springfield Machine Tool Co., Springfield, O., as applied to one of their lathes. It is made for the purpose of accurately backing off the teeth of taps, cutters, mills, hobs, etc., a tap being shown between the centers of the machine in the illustration. Oscillatory motion is given to the flexible shaft leading to the tool slide by a crank carrying the roller in contact with the cam as shown, the cam being driven through a train of gears from a pinion on the end of the spindle; this oscillatory motion giving reciprocating motion to the tool slide



Lathe Relieving Attachment.

through rack and pinion in the slide. The latter fits to the top of the cross slide, and can be set at an angle for backing off end mills, etc. The number of movements per revolution may be changed by varying the change gears, while the amount of each movement, governing the clearance to be given the cutter may be regulated by varying the throw of the crank.

MISCELLANEOUS TOOLS AND APPLIANCES.

L. Robbins, Worcester, Mass., has brought out a new patternmakers' lathe, built in two sizes, 20 and 24 inches. The headstock is swiveled, graduated in degrees, and is provided with a quick-acting cam binder.

A micrometer slide gage made by C. D. Clark, Torrington, Conn., measures by thousandths from 3-16 inch to 1¼ inch without extension pins, and with the latter up to 4¼ inches. It is useful as a sizing block for setting shaper or planer tools.

A turret head applicable to engine lathes and speed lathes is made by the Baker Machine Corporation, New Bedford, Mass. The shank of the head fits over the tail spindle of the lathe. The head is indexed by means of notches on the outside.

The Cincinnati Machine Tool Co., Cincinnati, O., have brought out an upright drill with a positive geared feed. Six changes of feed are obtainable by the movement of the graduated handle on a feed box mounted on the sliding head.

A 5-foot arm radial drill built by the Fosdick Machine Tool Co., Cincinnati, O., has 12 speeds with cone drive, and 18 speeds with a speed box. The arm swings on ball bearings; an automatic trip and a tap attachment are provided. There are 8 changes of feed.

A powerful single pitman, straight-sided press designed for deep stamping of metal up to ⅜ inch in thickness is built by the Toledo Machine & Tool Co., Toledo, O. Its crankshaft is 13 inches at the bearings. The press bed is 38x38 inches, the width between uprights 38 inches, and the stroke 14 inches.

The Espen-Lucas Co., Philadelphia, Pa., have placed on the market a new design of their cold saw cutting-off machine, similar to some of its predecessors, but redesigned so as to be heavier in some of its parts, for the purpose of driving a modern high-speed steel inserted-tooth saw up to its limit. It has cut 6-inch steel bars of 0.25 per cent carbon in six minutes.

A blueprint washing and drying machine has been brought out by C. F. Pease, 172 West Locust street, Columbus, O. With this device the washing of the prints is accomplished by a spray of water flowing over the treated side of the paper only. As the prints are not soaked through, the drying is a matter of but little time. Surplus water is removed from the print by a wiping device.

A large cold saw cutting-off machine adapted for steel foundry work has been designed by the Newton Machine Tool Works, Philadelphia, Pa. The saw is fitted with inserted teeth, and is capable of cutting off gates and risers up to 17 inches cross-sectional diameter. The ram has an automatic feed of 30 inches, the speed of which is varied through the friction disk, and power quick return.

The Willey electrically-driven shop saw has been added to the list of motor-driven tools manufactured by James Clark, Jr., & Co., Louisville, Ky. In this saw the motor is incorporated in the frame of the machine. The saw feeds by gravity and has an automatic stop which releases the switch when the work is cut off. It is designed for 12-inch saw blades, and cuts off stock 4½ inches in diameter.

A 2x26-inch turret lathe with a special equipment for handling a wide variety of work in a locomotive shop has been brought out by the Pratt & Whitney Co., Hartford, Conn. A special taper turner is provided for machining the long taper bolts used in locomotive frames. Another useful adaptation of this lathe is the turning and centering of forged bolts, the heads of which are somewhat eccentric.

A horizontal spindle boring, drilling, and milling machine built by the Newton Machine Tool Works, Philadelphia, Pa., has power feed and quick traverse in three directions. The speed of the 4½-inch spindle is varied by both mechanical and electric means, a main motor of 5 H. P. driving the spindle and the feeds of bar and saddle, while the feed on the base is by a separate motor of 3 H. P.

A quick-acting monkey wrench is made in four sizes from 4 to 15 inches by the Bay State Tool Co., 294 Washington Street, Boston. In this a screw with an interrupted thread, engaging with a similar thread in the jaw, replaces the usual screw and nut. By turning the thumb piece on the screw, the jaw may be slid in or out, and by a further turning of the thumbpiece the jaw may be locked in whatever position it then occupies.

An automatic press having five slides, designed especially for drawing and finishing sheet metal shells where a number of operations are required for finishing, has been gotten out by the Consolidated Press & Tool Co., Chicago, Ill. The shells made on a combination die are placed on a friction dial, a reciprocating feed carrying them thence from one die to another, the discharge being automatic. Such work as oil can tops, lantern parts, stove trimmings, etc., are turned out.

A 30-inch vertical turret boring and turning mill, designed by the Niles-Bement-Pond Co., New York, is particularly intended to use high duty steels. Numerous speeds and feeds are provided, and minor details of design contribute to rapidity of production. In a recent job fifty brass bushings 8¼ inches long and 4½ inches internal diameter were bored in a roughing and finishing cut in five and a quarter hours, the machine running at a cutting speed of 155 feet per minute.

The E. W. Bliss Co., Brooklyn, N. Y., have designed a press for perforating sheet metal whereby a whole sheet can be finished with a single operation. The sheet is clamped on a sliding table which is automatically fed under a slide which carries from one to fifty punches. Automatic feeds and a quick return motion are provided for the table. The machine is arranged to punch two 1-inch holes in ¾-inch iron or the equivalent of this work with smaller holes. The stroke is 2 inches. The ways are 27 feet long and are made to carry plates ¾x60x144 inches.

Something new in emery wheels has been brought out by the Corrugated Grinding Wheel Co., Philadelphia, Pa. The cor-

rugations are made across the cutting face of the wheel at an angle, the effect of the corrugation being said to be more rapid grinding with less heating of the work and a less tendency to glaze; hence much harder wheels than usual are made practicable. In a test of the cutting ability of one of these wheels before and after corrugating, a net gain of 140 per cent in time for the same amount of work was said to be obtained by the corrugation.

A heavy, vertical boring machine made by Baker Bros., Toledo, O., for the machining of automobile crank cases is furnished with a special revolving jig. The machine bores and faces one end of the case, after which the chuck holding the work is rotated one-half turn, and the opposite end of the crank case is finished. The chuck is locked in position by taper pins. The two bores of the crank case are not on the same center line, this being provided for in the chuck by having the latter bolted to the column distant from the center line of the spindle one-half the distance between the center lines of the two bores of the crank case.

* * *

FRESH FROM THE PRESS.

THE NORMAN W. HENLEY & SON CO., 132 Nassau Street, New York, have brought out an interesting chart showing a boiler room, including the boiler feed water heater, feed pump, etc., in isometric projection. Part of the boiler setting and of the boiler itself is broken away, so that all the details are visible and the feed water heater and pump are shown in half section. The boiler is of the water-tube type, with superheater. All the parts of the apparatus are numbered and named in a printed list which has 235 references. The price of the chart is 25 cents.

NOTES ON MECHANICAL DRAWING, INTRODUCTORY TO MACHINE DESIGN, by P. M. Chamberlain, Professor of Mechanical Engineering in Lewis Institute. 68 pages 6 x 9 inches, with 96 cuts. Published by the author at Chicago, Ill. For sale by McClurg & Co., Wabash Avenue, Chicago, Ill. Price, 75 cents.

This collection of notes represents the author's method of teaching mechanical drawing to first-year classes. Most of the problems are purely geometrical, but a few in machine detail are included. A number of useful tables are given at the back.

ELEMENTS OF MECHANICAL DRAWING, by Gardner C. Anthony, Professor of Drawing in Tufts College, etc. 152 pages, 6½ x 7¼ inches, with 196 figures and numerous sketches for problems. Published by D. C. Heath & Co., Boston, Mass. Price, $1.50.

This revised edition of Anthony's well-known work on drawing incorporates some radical changes from the older edition. The folding plates have been abandoned, the illustrations in this edition being printed with the text which obviously is a much more convenient arrangement. Many figures have been added and all have been redrawn. The problems with their sketch layouts are placed at the back of the book.

THE TESTING OF CONTINUOUS CURRENT MACHINES IN LABORATORIES AND TEST ROOMS, by Charles Kinzbrunner, Lecturer on Electrical Engineering and Design at the Municipal School of Technology, Manchester. 336 pages, 5½ x 8½ inches, with 249 illustrations and diagrams. Published by John Wiley & Sons, New York. Price, $2.00.

This work, which originated in the author's written instructions to his students in the Municipal School of Technology, Manchester, is intended for students in technical colleges, and for electrical and mechanical engineers generally who are engaged in testing work or in the installation of electrical machinery. Considering the character of the work and the great mass of matter contained, it is remarkably low-priced as such works go. It should be in the hands of every electrical testing engineer.

ELEMENTS OF MECHANICS, by Mansfield Merriman, Professor of Civil Engineering in Lehigh University. 172 pages, 4¾ x 7¼ inches, with 142 cuts. Published by John Wiley & Sons, New York. Price in cloth binding, $1.00 net.

The author says in his prefatory remarks that, fortunately, the elements of mechanics can be presented without the use of the higher mathematics, and the book in review is an effort in this direction. To study it understandingly a knowledge of plane geometry, elementary algebra and plane trigonometry only are required. Hence it is suitable for the use of manual training schools, and beginners in engineering generally. The chapters treat of the following subjects in the order noted: Concurrent Forces; Parallel Forces; Center of Gravity; Resistance and Work; Simple Machines; Gravity and Motion; Inertia and Motion. A valuable feature of the work is a large number of problems following each article of the different chapters, the working of which gives the necessary mental drill and grasp of the subject that nothing else can. Answers are given in the appendix to all problems, so that the student can verify his work.

THE CYCLOPEDIA OF APPLIED ELECTRICITY. Published by the American School of Correspondence, Armour Institute of Technology, Chicago, Ill. Five volumes and over 3,000 illustrations. Bound in three-quarters red leather. Price for the set $30.

Some time ago the American School of Correspondence brought out a library on modern engineering practice containing several volumes treating of mechanical construction, machine design, shop work, steam engines, boilers, etc. This set of books proved popular and it has now been followed by the "Cyclopedia of Applied Electricity," which is undoubtedly even more complete in its own special field than was the previous set of books. We understand that the contents of the books is substantially the material used by the instructing force of the school, and it is accordingly written in simple language and copiously illustrated. The various articles comprising the series have been written by leading technical writers, including professors of several colleges and other experts. The following is a brief summary of some of the most important features of the volumes:

VOL. I. ELEMENTS OF ELECTRICITY. The first section contains description of the fundamental laws of electricity; the second treats of the electric current and the relations of electromotive force, current and resistance as determined by Ohm's laws; the next of electrical measurements and an explanation of the system of C. G. S. units and other practical units; the next section is devoted to electric wiring and the installation of electrical machinery; the next takes up the electric telegraph, describing the Morse code, etc.

VOL. II. DYNAMO ELECTRIC MACHINERY AND STORAGE BATTERIES. Chapter I explains the theory and fundamental principles of the electric generator; Chapter II deals with direct-current dynamos; Chapter III with the different types of direct-current generators as made by the leading American electrical manufacturers; the next is a discussion of the direct car motor, chiefly a mathematical discussion. A special chapter is devoted to electric motors in machine shop service, and the volume concludes with a section on storage batteries, and their applications to different classes of work.

VOL. III. ELECTRIC LIGHTING, ELECTRIC RAILWAYS AND THE OPERATION OF DYNAMO-ELECTRIC MACHINERY. The following subjects are treated: The manufacture and properties of incandescent lamps; the mechanism of the various types of both direct-current and alternating-current arc lamps; power distribution for the lamps; illumination in public halls, offices, factories; shop lighting, electric railways; power supply and distribution; management of dynamo-electric machinery; power stations; central station engineering, and a brief chapter on "A Graphical Method of Recording Data of Boiler Tests."

VOL. IV. ALTERNATING CURRENTS AND AUTOMATIC CURRENT MACHINERY. The following are considered: The simplest type of alternator; advantages and disadvantages of the use of alternating currents for the transmission of power over long distances; measuring instruments; armature windings for single, double and three-phase machines; alternating current testing; synchromotors and induction motors; transformers; rotary converters; alternating-current calculations of efficiencies, performance curves of motors, etc.; and a chapter devoted to the Hewitt mercury vapor converter.

VOL. V. THE TELEPHONE. Section I takes up sound, primary and storage batteries, the history of the development of the telephone, description of its various parts, with a careful explanation of their action. Section II is devoted to simple open-line work, and carefully explains the setting of the poles, stringing of wires and guying. Section III describes the placing of overhead and underground cables, including testing, causes of cross talk, induction, transpositions and connecting. The use of modern lightning arresters and distributing frames, and the parts of the switchboard, are explained. Section IV gives a method of wiring switchboards. Section V explains common battery work, shows circuits of various systems, together with the trunk lines used with them. Section VI treats of maintenance, explaining the duties of each part of the working force of a telephone system. The automatic telephone system is described and an article on wireless telephony also appears.

NEW TRADE LITERATURE.

THE SPRAGUE ELECTRIC CO., New York City. Bulletin No. 505, treating of the flexible steel-armored hose, described in our March issue.

THE INGERSOLL-SERGEANT DRILL CO., New York. Form 35A, showing some of the different types of their air compressors, and listing their other products.

THE DE LAVAL STEAM TURBINE CO., Trenton, N. J. Catalogue B of the De Laval centrifugal pumps and steam turbines, whose characteristics are here fully described.

THE WASHBURN SHOPS, Worcester, Mass. Catalogue C, 1905, of the Worcester drill grinders, for wet and dry grinding. The different styles are shown and directions given as to their proper use.

THE INGERSOLL-SERGEANT DRILL CO., New York. Bulletin 2000, the first of a series describing labor-saving tools operated by compressed air, treats of the MacDonald rivet forge. The series will be sent to any one interested.

THE NATIONAL MACHINE CO., Hartford, Conn., successors to the Woodward & Rogers Co. Catalogue of sensitive drill presses, of many sizes, belt- and motor-driven; grinders, a centering machine, a horizontal tapping machine, etc.

THE C. W. HUNT CO., West New Brighton, N. Y. Pamphlets Nos. 051 and 052 showing respectively the Hunt industrial railways, and the general line of machinery, for conveying and hoisting and other purposes, which they manufacture.

THE CURTIS & CO. MFG CO., St. Louis, Mo. Illustrated catalogue, 1905, of pneumatic appliances. This describes and illustrates the company's air compressors, air hoists, air elevators and air cranes, and the book will be sent free upon application.

THE KEMPSMITH MFG. CO., Milwaukee, Wis. Loose-leaf catalogue of the Kempsmith milling machines. These are built in 13 sizes, and of the following types: hand, plain, plain with screw feed, plain with rack feed, universal, etc. Each type is here shown, with specifications.

THE JEFFREY MFG. CO., Columbus, O. Bulletin A, showing different views of a plant where their coal and ash handling machinery is installed. Special attention is called to their new "Class A Grab Buckets" of 48 cubic feet capacity for transferring coal from cars to bin or stock pile.

THE COLBURN MACHINE TOOL CO., Franklin, Pa. Pamphlet descriptive of their 53-inch boring and turning mill, which is adapted to a large range of railroad and machine shop work. Two half-tones show a front and a rear view of the mill, and its advantages and special features are here briefly pointed out.

THE WATERBURY BRASS CO., Waterbury, Conn. 1905 catalogue containing a complete list of the stock carried in their Waterbury and Providence warehouses, consisting of brass, copper and German silver in sheets, wire and rods; brass, copper and bronze in seamless and brazed tubing; and small brass wares of all kinds. The catalogue also contains quite a number of useful tables.

THE FOX MACHINE CO., Grand Rapids, Mich. Special catalogue No. 27, March, 1905, of the Fox machinery for wood and metal pattern work. This includes their universal wood trimmers, built in ten sizes and four styles, band saws, saw tables, buzz planer, pattern-makers' wood and gap lathes, etc., etc. The catalogue will be sent free to those interested in this class of machinery.

H. B. UNDERWOOD & CO., Philadelphia, Pa. Catalogue, 1905, of portable tools for railway repair shops. Portable boring bars for various purposes, a portable facing arm, portable valve seat rotary planing machine, locomotive cylinder or dome-facing machine, portable milling machine, portable crankpin turning machine, eccentric mandrel turning machine are among the products illustrated and described.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. "Graphite" for April. Monthly publication issued to make known the products of the company, which are graphite paint, and graphite in many forms for lubricating purposes. This issue is particularly interesting, containing hitherto unpublished cuts of notable bridges and buildings in different parts of the world, and other interesting information. Sent free upon request.

MANUFACTURERS' NOTES.

THE CROCKER-WHEELER CO., Ampere, N. J., announce the recent sale of four K. V. A. alternating-current generators for the sanitary district of Chicago.

THE DIAMOND DRILL & MACHINE CO., Birdsboro, Pa., owing to many changes in their products, have changed their firm name to the Birdsboro Steel Foundry & Machine Co.

THE STOCKBRIDGE MACHINE CO., Worcester, Mass., have made arrangements with the Niles-Bement-Pond Co., for the sole agency of their shapers in New York, Boston, Chicago and London.

THE DODGE COAL STORAGE CO., New York, have acquired the business of the United Telpherage Co., of New York. Communications

MODERN STEAM HOISTING MACHINERY.

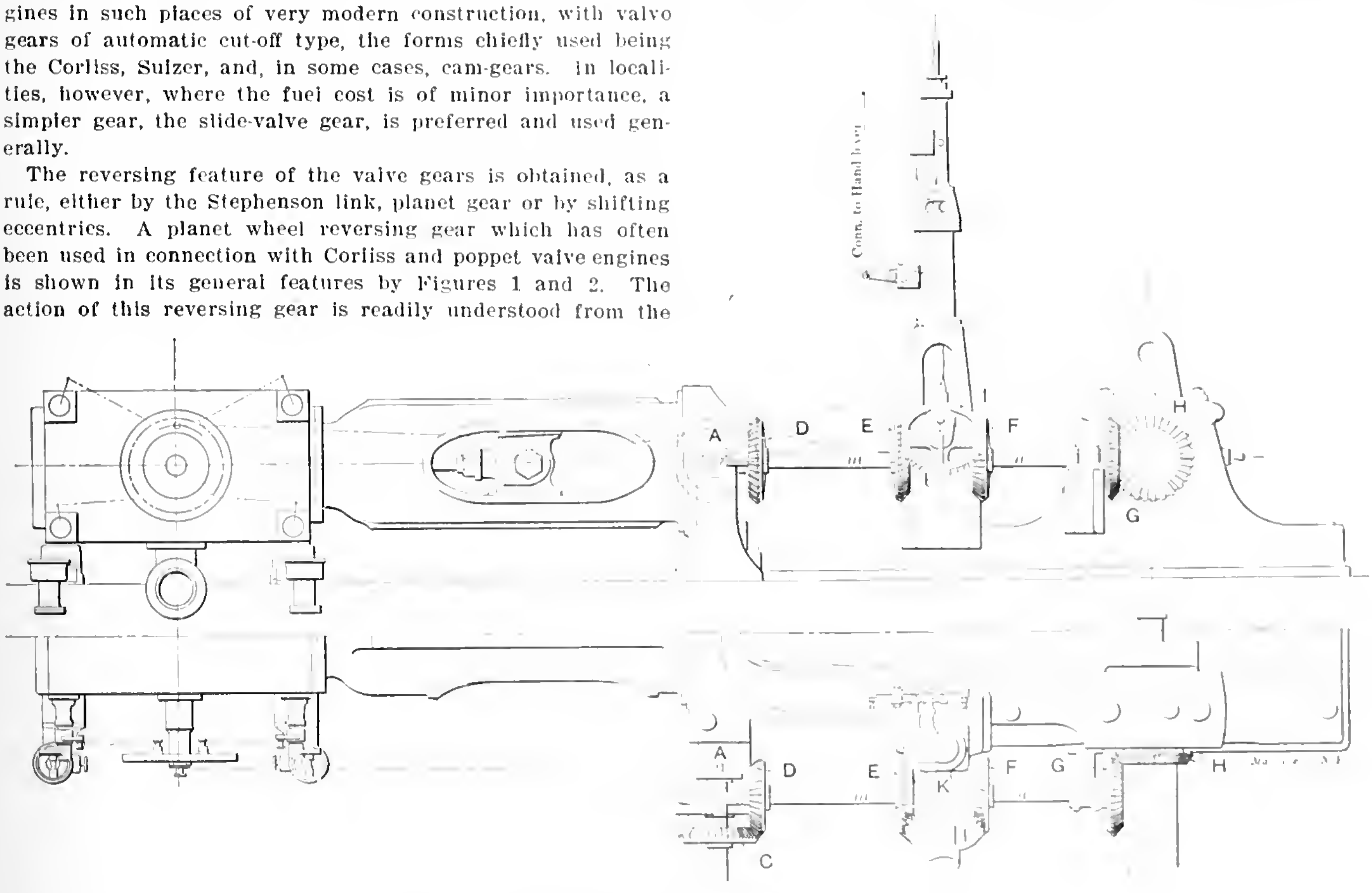
A. M. LEVIN.

Few classes of steam machinery, perhaps, include so many interesting details of construction as does the modern hoisting engine; the following description of some features of its design and auxiliaries, therefore, may not be without interest. In regard to the details of the engine proper but little can be said, as in this respect the hoisting engine does not differ materially from the steam engine in general; the valve gears principally employed in connection with hoisting engines, however, merit special account.

Economy in the consumption of fuel being generally an important consideration in mining districts, we find hoisting engines in such places of very modern construction, with valve gears of automatic cut-off type, the forms chiefly used being the Corliss, Sulzer, and, in some cases, cam-gears. In localities, however, where the fuel cost is of minor importance, a simpler gear, the slide-valve gear, is preferred and used generally.

The reversing feature of the valve gears is obtained, as a rule, either by the Stephenson link, planet gear or by shifting eccentrics. A planet wheel reversing gear which has often been used in connection with Corliss and poppet valve engines is shown in its general features by Figures 1 and 2. The action of this reversing gear is readily understood from the figures, if we note that what is required, in order to obtain a reversed motion of the engine, is simply to shift the driving pin A, relatively to the crank, through an angle of 180 degrees minus twice the angle of advance; the pin A being directly connected with the wrist plate. This shifting is performed by means of the bevel gears, C, D, and E, which are all rotated the required angle, relatively to the gears F, G, and H, when reversing. The reverse lever K, mounted on trunnions in the center line, m-n of the driving gears, performs the shifting of the gears by means of the planet gear, I, which is journaled on the end of the lever. If we suppose that the gear F is stationary, and that we swing the reverse lever, together with the gear mounted on it, through a certain angle, the effect will be to rotate the gear E through an angle of twice the amount to which the reverse lever is swung. The reverse engine is, therefore, required to swing the lever through an angle of ½ (180 degrees — 2 × angle of advance), or somewhat less than 90 degrees.

The space on the engine shaft occupied by the driving gears being generally somewhat greater than that which would be required by two eccentrics connected to a link, the principal claim of advantage, in using this type of reversing mechanism in connection with Corliss engines, is the fact that it gives an invariable motion to the wrist-plate. A link motion, properly laid out, however, will give results which are fully acceptable in this respect, and it will usually make a simpler and neater arrangement as well. In connection with poppet valve or Sulzer gears, however, the planet-wheel reversing gear makes a suitable arrangement.



Figs. 1 and 2. Hoisting Engine with Planet Wheel Reversing Gear

The Power of Hoisting Engines

For the sake of clearness it is most convenient to consider direct-connected or first-motion and geared hoists separately.

FIRST-MOTION HOISTS.

The size of the cylinders is determined by the maximum power required to raise the total load, at any point in the course of its elevation. The power required to raise the load when the cage is at the bottom level will be a maximum, due to the unbalanced lead of rope, if the hoisting drum is

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cylindrical. In the case of a conical drum, or a flat rope reel, the point at which the maximum lifting moment is required depends on the ratio between the large and small diameter of the drum and on the depth from which the load is elevated. Conical drums or reels are, however, seldom designed so as to fully compensate for the weight of the rope, so that, as a rule, the maximum moment of the load occurs, even in the case of such drums, when the load is at the bottom level. Having ascertained what the maximum moment of the load is, the areas of cylinders are proportioned so that the work generated during one revolution of the engine equals that required to wind up the load the distance corresponding to one turn of the drum, plus the work due to frictional resistance. An average value of the friction loss is 20 per cent of the theoretical power of the engine, which amount should not be exceeded under ordinary circumstances. We get, therefore:

$$L\,c = 0.8\,A\,P_{m\ max.}\,2\,s \qquad (1)$$

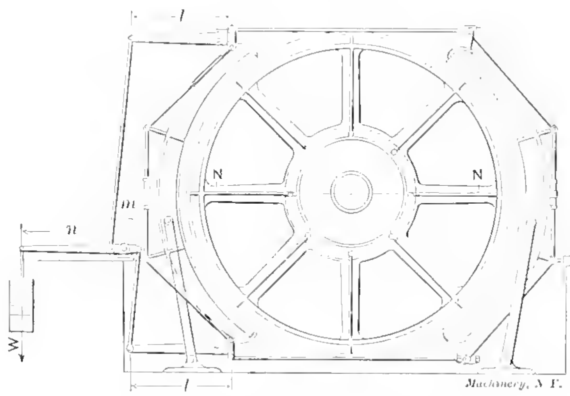


Fig. 3. Type of Brake supported by Links.

where L = maximum unbalanced load to be raised, in pounds. In a double-cage hoist one loaded cage must often be raised, without being counterbalanced by the other, when L would equal the sum of the weights of cage, load and rope.

D = diameter of drum in feet, at a point where the maximum load occurs.

A = total cylinder area in square inches; in case of two cylinders, the area of both.

S = length of stroke of piston in feet.

c = circumference of drum = 3.14 D.

$P_{m\ max.}$ = mean pressure in cylinder at a late cut off, in pounds.

This mean pressure can properly be estimated at

$$P_{m\ max.} = \begin{cases} 0.9\ P \text{ for slide valve engines.} \\ 0.7\ P \text{ for Corliss engines.} \end{cases}$$

if P = boiler pressure.

Inserting these values in equation 1 we get

$$\left.\begin{array}{ll} L = 0.5\,A\,s\,\dfrac{0.9\,P\text{-}b}{D} & (2) \\[2ex] A = 2\,\dfrac{D\,L}{(0.9\,P\text{-}b)\,s} & (3) \end{array}\right\} \text{for slide valve engines.}$$

$$\left.\begin{array}{ll} L = 0.5\,A\,s\,\dfrac{0.7\,P\text{-}b}{D} & (4) \\[2ex] A = 2\,\dfrac{D\,L}{(0.7\,P\text{-}b)\,s} & (5) \end{array}\right\} \text{for Corliss and Sulzer engines.}$$

where b = the back pressure in the cylinders.

In estimating the horse power required to run a certain load at a required speed in a mine shaft, the resistance due to the wind pressure acting on the cage must be considered as well as the frictional resistances in the engine. This may sometimes be considerable. To cover both this resistance and the engine friction from 25 per cent to 40 per cent of the theoretical horse power should be added, and we get therefore:

$$H\,P = 1.25 \text{ to } 1.4\,\frac{L}{33{,}000}\,h \quad (6)$$

where $H\,P$ = the maximum horse power required if L is the maximum unbalanced load, and h = the speed of the cage in feet per minute.

The cross section of one cylinder which would be required in order to start the load if one crank gets on dead center, is:

$a = 1.1\,\dfrac{D\,L}{s\,(P\text{-}b)}$ (7) in which equation 10 per cent has been allowed for friction in the engine journals and for the stiffness in the rope. This area is practically the same as is required for a slide valve engine, according to equation 3.

Equation 7 shows that the sizes of the cylinders as determined from equations 3 and 5 will also be ample to start the load, if the positions of the cranks happen to be such as to require one engine alone to do the work momentarily.

Having determined the sizes of the cylinders for a hoist according to the foregoing formulas, which are as a rule considered sufficient for this purpose, it might be that such a hoist would, under some circumstances, be too slow in practical operation. It would be well, therefore, to ascertain how the engine would meet the requirements of speed in each case.

Generally the maximum unbalanced load is far in excess of the load which the engine is required to handle under average circumstances, and, therefore, the question of speed when working under exceptional requirements does not carry much importance. In a case where the maximum unbalanced load is also the one which is most generally occurring, however, the cylinders as determined by equations 3 and 6 may be too small.

The following method of computation can be used when it is desired to ascertain the actual time that will be required for *speeding up* to the normal velocity which has been decided upon.

The energy developed by the engine during the time t, when speeding up the load from a velocity of o to a velocity v, is:

$$\frac{A\,\mu\,P\,s\,v\,t}{\pi\,D} \text{ foot pounds.}$$

where $\mu\ P$ = mean effective pressure in the cylinders.

This energy is expended in:

(1) Acceleration of the total unbalanced load $= \dfrac{1}{2}\,\dfrac{L}{g}\,v^2$,

(2) Acceleration of the rope drum $= 2\,I\,\dfrac{v^2}{D^2}$,

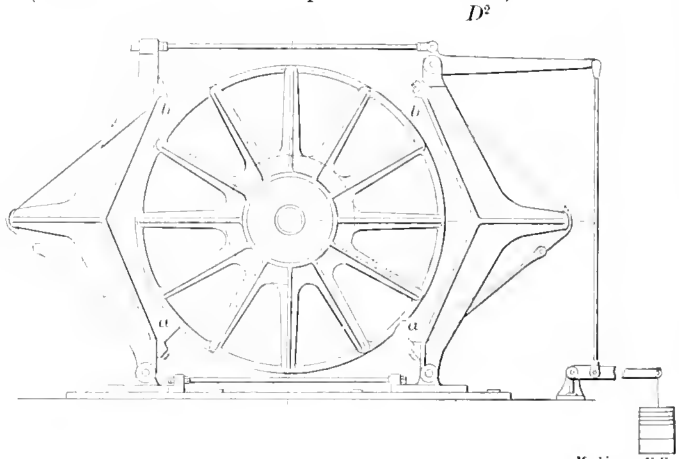


Fig. 4. Simpler but Less Successful Type of Brake.

where I = moment of inertia of the rope drum, and

(3) Lifting the load $= \dfrac{1}{2}\,v\,t\,L$

We get therefore:

$$\frac{A\,\mu\,P\,s\,v\,t}{\pi\,D} = \frac{1}{2}\,\frac{L}{g}\,v^2 + 2\,I\,\frac{v^2}{D^2} + \frac{1}{2}\,v\,t\,L.$$

I, the moment of inertia, $= \dfrac{W}{g}\,\rho^2$

where ρ = the radius of gyration of the drum and W = the weight of the rope drum.

Inserting this value for I and solving for t we get:

$$t = \frac{\pi D r \left(L + \frac{4}{D^2} W \rho^2\right)}{g\,(2\,\mu\,P\,A\,s - \pi\,D\,L)} \qquad (8)$$

All symbols in the above expression represent known quantities, except ρ. The latter can be obtained exactly only after the design of the drum has been decided upon, but an approximate value in terms of the diameter of the drum can now be given within limits close enough for practical purposes.

We can say that: For cylindrical drums $\rho = 0.9 \frac{D}{2}$

For conical drums $\rho = 1.1 \frac{D}{2}$

For rope reels $\rho = 1.2 \frac{D}{2}$

In the case of conical drums and rope reels D means the small diameter, as this is the diameter of the winding of the rope when the cage is started from the bottom level, and the diameter to which the value of ρ is best referred.

With the above assumptions we get

$$\rho^2 = 0.8 \frac{D^2}{4} \text{ and } 1.4 \frac{D^2}{4},$$

respectively, for cylindrical drums and rope reels, with an intermediate value for conical drums.

These approximate values for ρ inserted in equation (8) give

$$t = \frac{\pi D r \left[L + (0.8 \text{ to } 1.4)\, W\right]}{g\,(2\,\mu\,P\,A\,s - \pi\,D\,L)} \qquad (9)$$

From this equation it is convenient to get an approximate value of t. If this time for speeding up should appear unnecessarily long, we may properly increase the size of the cylinders somewhat, in order to obtain better results. It should be noted that $\mu\,P$, in the above formula, is to be taken only a little less than the initial effective pressure as, in starting, the engines would generally take steam full stroke, until the governor was up to speed and commenced to cut off.

As an example to the above we may take an actual case of a four-cylinder hoist, with a drum partly conical and partly cylindrical. The data are as follows:

Cylinders 34 inches in diameter × 5 foot stroke.

Total area of cylinders = 3,600 square inches.

Load, including rope, cage, cars and ore = 42,000 pounds.

Weight of drum, 250,000 pounds.

Small diameter of drum, 18 feet.

Normal speed of cage, 50 feet per second.

The drum being in this case of special construction, we call

$$\rho^2 = 1.1 \frac{D^2}{4}.$$

Initial steam pressure = 120 pounds by the gage.

For a non-condensing engine, therefore, an average value of $\mu\ P$ would be 100 pounds, and the time during which the engines are speeded up is

$$t = \frac{3.14 \times 50 \times 18\,(42{,}000 + 1.1 \times 250{,}000)}{32\,(2 \times 100 \times 3600 \times 5 - 3.14 \times 18 \times 42{,}000)} \text{ or}$$

t = 23 sec.

GEARED HOISTS.

The size of cylinders required for a geared hoist would evidently be the same as that required for a first-motion hoist multiplied by the ratio of the radius of the pinion to the radius of the gear, if it were not for the fact that the friction in the geared hoist would be greater than the friction in the direct-connected one. Taking this into consideration, and allowing 25 per cent of the total power developed for friction, we get:

$$L = 0.48 \frac{(0.9\,P - b)\,A\,s\,R}{D\,r} \qquad (10)$$

$$A = 2.1 \frac{D\,L\,r}{(0.9\,P - b)\,s\,R} \qquad (11)$$

for slide-valve engines.

$$L = 0.48 \frac{(0.7\,P - b)\,A\,s\,R}{D\,r} \qquad (12)$$

$$A = 2.1 \frac{D\,L\,r}{(0.7\,P - b)\,s\,R} \qquad (13)$$

for Corliss and Sulzer engines.

where r = the radius of the pinion.

R = the radius of the gear.

Brakes.

The brakes variously used on the modern hoisting engines are chiefly of two kinds: The band-brake, consisting of a wood- or fiber-lagged steel band, which tightens around a cast-iron brake drum, and the post-brake; this latter consists, as shown in Fig. 3, of two opposing wood-lagged upright beams which are pressed against the brake drum by means of steel rods passing between them. The second form of brake has the advantage that it is more quickly relagged with wood when occasion demands, and that the frictional shoes do not encircle the entire drum; for this reason the brake runs cooler than the band-brake. The post-brake has frequently been constructed as shown in Fig. 4, but this construction is not to be recommended. When carefully adjusted, and left in such condition, this brake may give good satisfaction, but after any careless readjustment of the beams, when the wood lining has worn down, the setting of the brake is liable to cause the brake-beam to grip hard at the bottom of the wood shoe at a. After the shoe has worn away at this point, the bearing will principally be at the top of the shoe, at b. In either case the reel is forced against the shaft with an undue pressure which is liable to cause abrasion of the reel-bushing. Besides, a large brake drum is liable to get somewhat out of round, on account of the expansion by heat produced by friction. In such a case a severe pressure will be borne by the reel-bushing if the brake-beams are not hinged in a somewhat yielding manner, often severe enough to cause the destruction of the brake-beam itself. Without doubt, the most correct and reliable way is to support the brake-beams by links as shown in Fig. 3, in which case any undue wear of the reel-bushing and uncalled for strain in the beams themselves are avoided.

The holding power of the post-brake can easily be estimated for a given weight W in pounds, setting the brake, if we know the coefficient of friction between brake-shoes and drum. Referring to Fig. 3, the normal pressure between each brake-beam and the drum is

$$N = \frac{1}{2} \frac{n}{m} \frac{l}{a} W$$

and from this expression we get

$$L\,R = f\,r \frac{n}{m} \frac{l}{a} W \text{ or} \qquad (14)$$

$$W = \frac{L\,R\,a\,m}{f\,r\,n\,l} \qquad (15)$$

where f = coefficient of friction between the shoe and drum. This coefficient varies somewhat for different materials used in the brake-shoe. When basswood or cottonwood shoes are used, a proper value would be f = 0.25.

L = maximum unbalanced load in pounds.

R = radius of the rope drum.

r = radius of the brake drum. This radius is generally made as large as convenient. For flat rope reels it is equal to the outside radius of the reel; for cylindrical drums it equals the radius of the rope drum, and for conical drums it often is equal to the radius of the smaller end of the cone.

The holding power of brake-bands is computed by the formula

$$L\,R = P\,r\,(e^{\mu\alpha} - 1) \qquad (16)$$

and the force with which the band should be tightened in order to hold the load

$$P = \frac{L\,R}{r\,(e^{\mu\alpha} - 1)} \qquad (17)$$

where P = the force with which the free end of the band is pulled.

$e = 2.71828$, the base of the Naperian system of logarithms,
$f =$ coefficient of friction,
a $=$ the part of the circumference 2π around which the band is wound; for instance, if the brake-band is wound $\frac{2}{3}$ around the full circumference then $a = \frac{2}{3}\,2\pi = 4.19$.

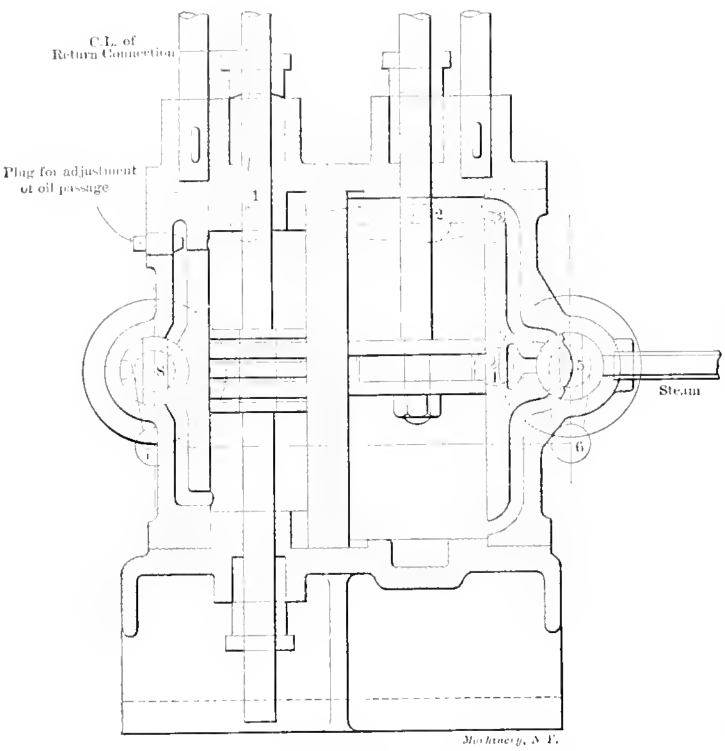


Fig. 5. Cylinders of Steam Reversing Engine.

The following table will be found convenient when solving questions relating to this subject:

f	$\frac{a}{2\pi} =$ 0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.18	$e^{fa} =$ 1.40	1.57	1.76	1.97	2.21	2.47	2.77
0.25	$e^{fa} =$ 1.60	1.87	2.19	2.57	3.00	3.51	4.11
0.40	$e^{fa} =$ 2.13	2.73	3.51	4.52	5.81	7.47	9.60

The question of the strength of the brake band is very simple. The principal condition is that the tensile strength of the anchored end of the band should be ample to hold the load with a large factor of safety, to allow for vibrations which sometimes are quite severe, thus:

$$A = \frac{R}{r}\,\frac{F}{s}\,L$$

where $A =$ the sectional area of the band in square inches.
$S =$ tensile strength of the material.
$F =$ factor of safety,
and R and $r =$ the radii of the rope drum and brake drum.

The band is generally made of steel of about 60,000 pounds tensile strength; $\frac{S}{F}$ should therefore be taken at 6,000 to 8,000 pounds.

Both band- and post-brakes are generally operated on the gravity principle for the larger engines where steam power is used to set the brake. The advantage of this arrangement is that, in case the steam pressure should accidentally be shut off from the cylinder, the brake weight would still keep the brake set.

In designing a brake engine cylinder the stroke should not be made too short, for by a longer travel and therefore closer control of the brake piston a more graduated brake pressure can be obtained, with consequent better results when lowering the cage with the brake.

The brake engine is generally provided with an oil cylinder for giving a steady motion to the piston. This oil cylinder is sometimes fitted with an automatic controlling valve like that of the reverse engine; sometimes only a plug valve for adjustment of the oil passage is provided. This latter arrangement is quite satisfactory where the duty of the brake is only to hold the load, but where lowering of timber is done with the brakes, an automatically-controlled oil valve is much to be preferred.

Steam Reversing Gear.

A section through the cylinders of a steam reversing engine is shown in Fig. 5. This construction is suitable for being connected directly to the reverse lever; various arrangements are, however, found in practice. The reverse engine is generally provided with a floating lever arrangement, as shown in dotted lines at 1, 2 and 3, Fig. 5. Several positions of the floating lever with the resulting valve movements are shown by diagram in Fig. 6. The purpose of the floating lever arrangement is to so control the piston that it will always take a position which corresponds with that of the operating hand lever; for instance, if the hand lever is thrown full over, the piston will move to the corresponding end of its stroke, and closing the steam and oil valves when arriving at this position, will be locked there until the hand lever is thrown to a new position.

Referring to Fig. 6, the right-hand part of the figure shows the movement of the reverse arm by which the position of the link is reversed through the action of the hand lever. This figure is really the upper part of Fig. 5, the piston rods and uprights being shown broken in each figure. In the operation of the floating lever, which is directly back of the cylinders in Fig. 5, the point 2 is connected to the hand lever, point 3 to the steam and oil valves by the bell cranks and linkages shown, and point 1 is joined to the oil cylinder connecting rod as shown, by what is called the return connection. Point 2 is now, for example, raised by means of the hand lever when point 1, being anchored to the comparatively heavy reciprocating parts, acts as fulcrum, and point 3 is accordingly raised as shown in diagram 2, opening the steam valve and the oil by-pass valve, admittting steam below the piston, and allowing oil to pass from the upper side of the oil piston to the lower side. The piston accordingly rises, and, point 2 now acting as fulcrum, point 1 will be raised by the return connection, and point 3 returned to its original position, as shown in diagram 3, Fig. 6, thus closing the valves. The object of the oil cylinder is simply to prevent shock, as the oil slowly passes from the forward to the back side of the oil piston, past the regulating plug and through the by-pass valve. For the next reversal of the link point 2 would be lowered, when the steam port above the piston would be opened for the passage of steam and the piston lowered.

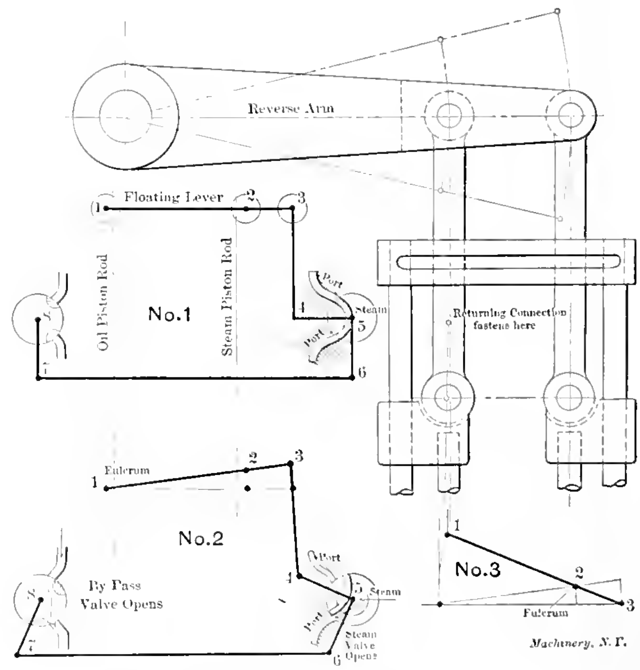


Fig. 6. Diagram illustrating the Floating Lever Mechanism of Valve Gear.

The size of the brake-engine cylinder is proportioned so as to lift with ample margin for certainty the heaviest brake

weight which, according to equation 15, is required to set the brake. The different leverages on which the engine cylinder and the brake weight act should of course be taken into consideration. When the brake is set, the steam is sometimes admitted on top of the brake engine piston, thus making the holding power of the brake doubly certain. However, the weight should in each case be amply heavy to hold the load when acting alone.

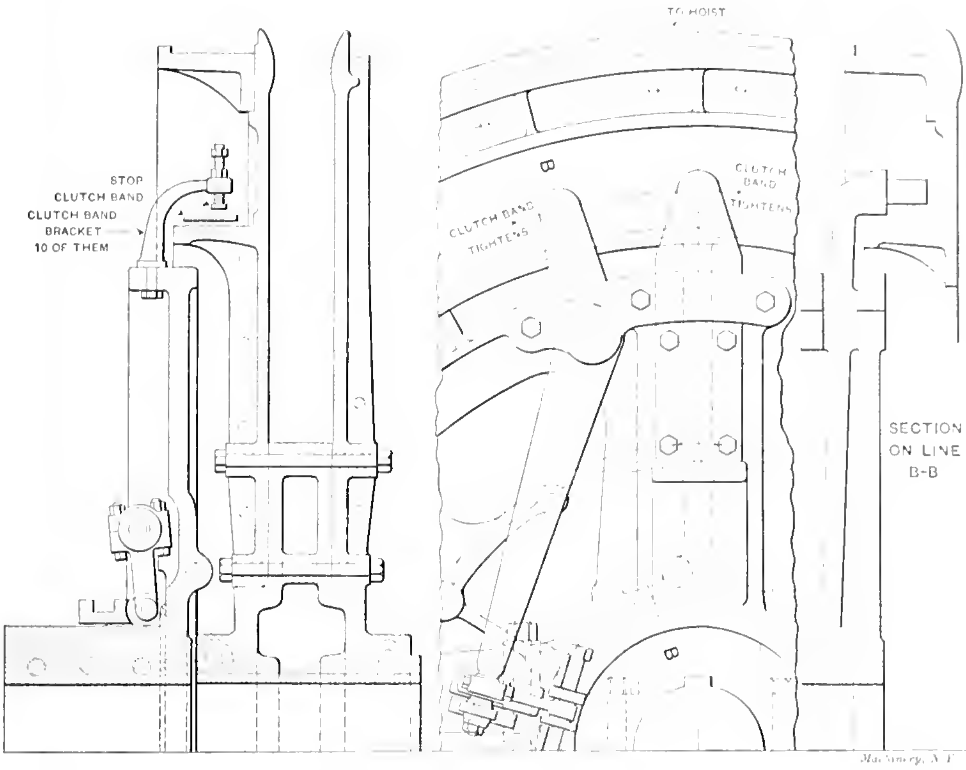


Fig. 7. Details of Band Clutch Wheel.

Clutches.

In connection with double-drum hoists the two hoisting drums are often required to be independent of each other, so that the cages can be operated in balance, or separately as desired. This feature is particularly advantageous when lowering timber to the different levels of a mine.

Various forms of clutches are employed for connecting and disconnecting the drums from the driving gear. Tooth clutches are quite satisfactory for smaller drums, although somewhat slow to operate. For large engines the band clutches are, however, nearly exclusively used. These can be easily proportioned by following the formula given for the holding power of band-brakes.

Fig. 7 gives various sections through a band-clutch wheel, showing the arrangement of levers for the operation of the clutch. In the left-hand figure is shown one of the stops, back of the band, against which centrifugal force throws the band when revolving free. The movable end of the band is attached to the pin in the end of the lever, pivoted on the clutch wheel, which is solidly keyed to the driving shaft. The other end of the band is held by a pin rigidly connected to the clutch wheel, so that by swinging the movable end of the band toward the fixed one the band is tightened, gripping the clutch ring cast together with the rope reel. In large hoists the clutch is often operated by a separate clutch engine.

Miniature.

The miniature, or indicator, as the device is called, which shows the operator the position of the cage at all times, consists, essentially, of a hand moving over a dial on which the different stations are marked. The hand is geared, from the main shaft, in such a way that a certain number of turns of the drum, corresponding to the unwinding of, say, one hundred feet of rope, give to the hand a motion of a corresponding arc on the dial. A second hand moving on the same dial is sometimes provided. This hand makes one full revolution while the cage is moving the distance between the first station below the surface and the surface landing.

Since the main hand is positively geared from the drum shaft, it moves over equal arcs on the dial for equal numbers of turns of the drum. One difficulty arises on this account in connection with conical drums or band-reels, where the hoisting band is wound upon itself when hoisting. In these cases it may be that twice the number of turns of the drum is taken for hoisting one hundred feet when the cage is at the bottom levels that is taken when the cage is near the surface. Therefore the distances between the station marks on the indicator dial will be of correspondingly unequal lengths. To correct this feature, the indicator has in some cases been provided with specially-constructed gears which give to the indicator hand a fast and a slow motion, neutralizing the fast and slow motion derived from the drum-shaft. This feature complicates things somewhat and would not be desirable except in special cases in connection with deep hoisting. Fig. 8 is chosen as an example showing all these refinements. In this figure the primary hand, pointing down, is solidly connected with the drum shaft through the hollow sleeve, snake wheel and pinion, vertical shaft, and two sets of miter gears not shown. This motion, therefore, follows the rope drum, and shows correctly the location of the cage at all times. The arm A, secured to the hollow sleeve, follows the motion of the primary hand, so that when the latter arrives at the station marked 1, the arm A comes in contact with the tongue B and rotates this about its pivot. On the shaft to which B is secured is also secured the sector gear and weight W, the sector being in mesh with the pinion P. Arm A keeps in contact with tongue B during the progress of the primary hand from station 1 to the surface, during which time pinion P makes on complete revolution. As pinion P is on the central spindle S, which passes through the hollow shaft before mentioned and the second hand, pointing up, is also on this spindle, the latter is moved one turn around

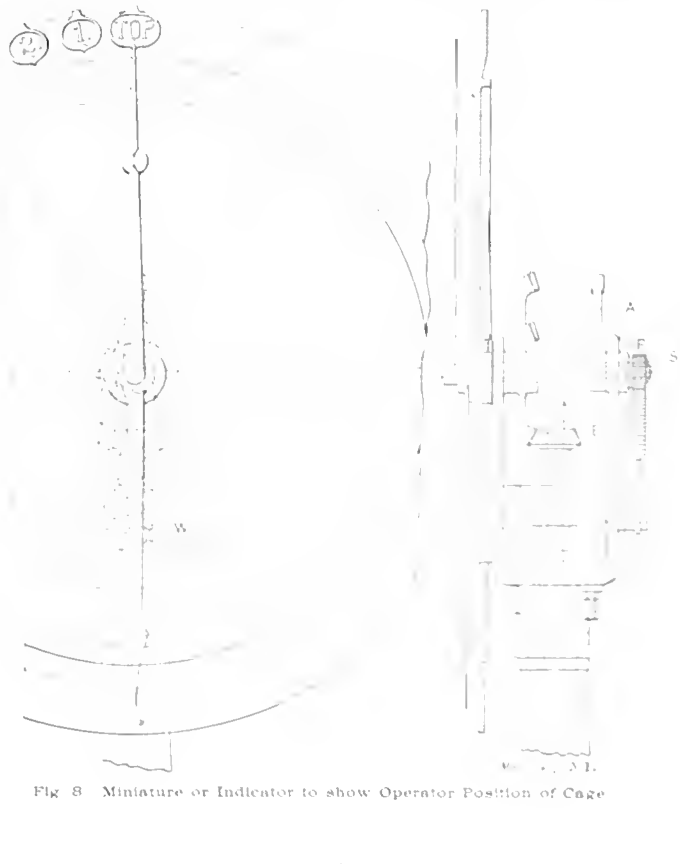


Fig. 8. Miniature or Indicator to show Operator Position of Cage.

the dial by the action of the sector and pinion, thus locating more closely the position of the cage while it is progressing from the first station to the surface, than would the primary hand in moving the short distance from mark 1 to the top of the dial. When the cage is again lowered down the shaft, the weight *W* returns the tongue *B*, the sector, and the second hand to their initial positions. The refinements shown in this construction are not as a rule necessary in ordinary practice.

* * *

VARIABLE SPEED MECHANISMS.—1.

THEIR DEVELOPMENT AND GENERAL PRINCIPLES.

Almost from the time that machines were first invented the need has been felt for some means of varying the velocity ratio of the driven or work spindle to the source of power. It is true that this was not a serious want at first, for the primitive machines being driven by hand or foot power could be speeded at the will of the workman (within narrow limits), but, strangely enough, what is probably one of the first machines ever used by mankind contained a variable speed feature. It is generally believed that the potter's wheel, a form of the lathe, was the first machine because of its intimate relation to working clay, the first material largely used in the constructive arts. It consisted of a circular table supported on a vertical axle, and near the base of the axle was attached another disk or wheel by which the work table was propelled with the foot. Now, since the sizes of pots and other circular vessels vary in diameter, it follows, of course, that the smaller ones should be formed at a higher rate of rotation than the larger ones in order to get the proper peripheral speed necessary for shaping the wet clay. The workman could vary the speed by moving his foot faster, but there is a natural rate of action which a man must follow in order to work continuously without excessive fatigue. In propelling the potter's wheel he could maintain about an even stride, no matter what the diameter of the work, by merely shifting the position of his foot relatively to the axle. When shaping a small pot, if he struck the wheel nearer the axis of rotation it would increase the speed with practically no change in the physical exertion required and *vice versa*. Hence we see that the first and primitive machine contained an ideal variable speed mechanism for that period, which, however, can scarcely be said to exist to-day in spite of our boasted progress and mechanical skill.

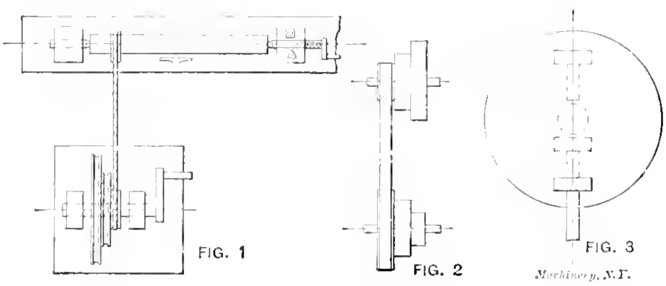


FIG. 1 FIG. 2 FIG. 3

Machinery, N.Y.

In the natural course of evolution it was but a step from the potter's wheel with vertical axis to the horizontal lathe with stationary poppets for turning forms of wood and iron. The work in this case takes the place of the axle. Although the lathe did not at first have a rotating spindle, and was therefore in some respects a still more primitive machine than the potter's wheel, in the pole-lathe it did contain the feature of constant speed at the surface of the work. This, of course, is equivalent to a variable speed work spindle, since the first object of the variable speed device in a lathe is to maintain a fixed rate of cutting speed irrespective of the diameter of the piece being turned. Now the pole-lathe consisted of two poppets supported on a wooden bed, and suspended from the ceiling was a wooden spring-pole, to the free end of which was attached a strong cord. This cord was wound once around the piece to be turned, and the loose end was carried down to the floor where it was formed into a loop for the workman's foot. In improved forms of the pole-lathe a rude treadle was provided instead of the loop. When the foot was depressed, the work piece was turned by the cord against the cutting tool, the spring-pole of course depressing at the same time. With the upward lift of the foot the spring-pole raised the cord and turned the work in the opposite direction. The point to be noticed is that no matter what the diameter of the work piece, it would rotate against the cutting tool with approximately the same working speed—the ideal condition when working various diameters in metal of the same characteristics, and the one for which we are yet striving. With the treadle the workman could also vary the working speed if he so desired by shifting the position of the foot on the treadle, thus making the work turn faster or slower with an even motion of the foot.

The pole-lathe, however, had the serious objection that the work did not turn continuously, but was turned alternately in opposite directions. A very high degree of skill was required to do satisfactory work, as the turning tool had to be lifted the moment the work began to turn backwards, and had again to be brought to cutting position when the reverse movement began. Hence the application of a driving wheel connected by a cord to drive the work continuously in one direction. The driving wheel, which was turned by a crank, was mounted on a separate stand or base placed to one side of the lathe and was usually provided with three grooves. See Fig. 1. The cord was carried directly by the work, if of ordinary size, and if smaller a pulley was sometimes mounted upon it in order to give it the necessary turning moment. The first record that we have of this combination, according to J. J. Holzpffel in his interesting work "Turning and Mechanical Manipulation," appeared in the "Manuel du Tourneure," published in 1816, but doubtless this principle of varying speed had been used many years before, for in Shopper's work, 1568, is shown an illustration of the wheel driving the work of a lathe, and doubtless the possibilities of changing the speed by a number of grooves of varying size must have been understood at this date. In this early machine, the driving cord also ran directly on the work, or if it was too small a pulley was mounted on the work piece, and the cord run on the pulley. This expedient was resorted to in order to prevent slipping of the cord, but it made necessary some means for compensating for loss of cutting speed, hence a number of grooves in the driving wheel. This type of machine, of course, required two workmen, one to turn the crank and the other to handle the cutting tool. Hence the preference for the foot-power lathe, having the driving wheel beneath the lathe shears, and with the advent of the rotating spindle in the early part of the nineteenth century came the combination

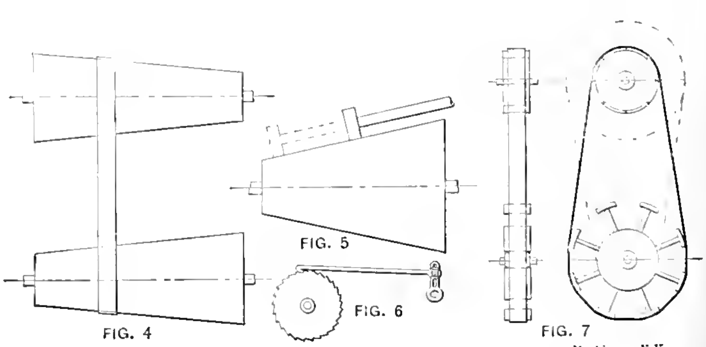


FIG. 4 FIG. 5 FIG. 6 FIG. 7

Machinery, N.Y.

of the driving wheel with a number of grooves and a pulley mounted on the spindle having an equal number of grooves for the cord. In this we have the familiar cone pulleys, Fig. 2, now generally employed for changing speed.

While the cone pulley is an effective means of varying speed ratios, it requires a momentary cessation of the work for changing it from one step to the other. This is found objectionable, not only because of the time lost, but also, in the case of lathe work, because of the marking of the work where an abrupt change of speed takes place. Again, in many machines it is desirable that the changes or grades of speed merge imperceptibly, or that the change from one rate to another take place without the necessity of human intervention, the change being effected by the machine itself or some outside influence as occasion may require. For light powers the disk wheel and friction roller, Fig. 3, the principle in effect first employed in the potter's wheel, has been used and is still used in a great variety of forms as we shall see. The disk and friction wheel

also has a useful characteristic of reversing the direction of rotation by traversing the friction wheel across the center of the disk. The smooth cone pulleys, Fig. 4, have been used very largely in textile machinery, where it is necessary to gradually vary the speed, and where it was desirable that the change be effected automatically. A combination of the principle of the disk wheel and the cone pulley is that of Fig. 5, the plate being replaced by a friction disk. The change in velocity ratio is, of course, only one-half as great with this arrangement as it would be with two cone pulleys of equal taper connected by a belt. Although the cone pulley is doubtless a very early invention, it appears to have been patented in England in 1841 by J. D. Bodmer, and was used by him in his remarkable improvements of machine tools in ratios of 9 to 1, and sometimes as high as 18 to 1. The ratchet device of Fig. 6, in one form or another appeared early in machine tool design, and has been used almost entirely for varying rates of feed, but as we shall see later, this principle has also in later years been applied in variable speed devices for varying the rate of driving the machine. In Fig. 7 we have the expanding pulley, a difficult mechanism to properly design, but one that has been used with moderate success in many forms of patented speed-varying mechanisms, as will be shown in the review of the principal United States patents to follow.

In connection with the stepped cone pulley we must not neglect the familiar back gear of the lathe, Fig. 8, which when properly designed, doubles the range of speed variation and changes the effective turning moment of the work in direct proportion to the change of speed. This device was doubtless an early expedient of iron workers to increase the effective working power of the foot-power lathe. It obviously came into use after the development of the rotating spindle. The triple back gear is but an extension of this principle, found

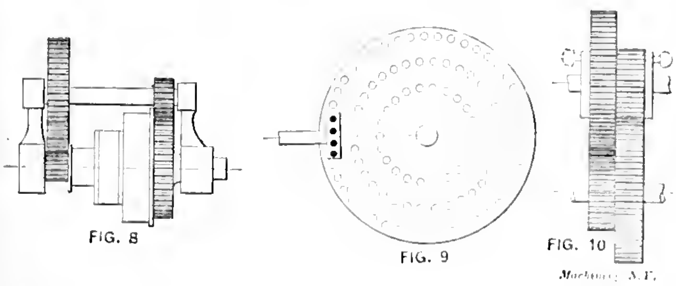


FIG. 8 FIG. 9 FIG. 10

necessary as larger and more powerful lathes were built. A variation in the back gear construction, doubtless of early use, is that indicated in Fig. 10. Two gears are mounted firmly on a shaft but the opposing gears are loosely mounted on another shaft. On each side of these gears is mounted a flange firmly keyed to the shaft. To make either gear drive a loose pin is inserted through the flange on that side into the gear, thus making the flange and gear turn as one.

In Fig. 9 we again have in effect the old disk and friction wheel with the friction feature left out. As many concentric rows of round pins are provided on the disk as there are speed changes wanted, three being shown in this case. The small wheel or pinion has holes to match the pin teeth. This primitive arrangement has been used in many forms and with good success with comparatively light work. An improved form makes the pins modified bevel teeth and teeth of corresponding shape are provided in the pinion. With narrow faces it is possible to change this arrangement from one speed to the next by shifting the pinon shaft longitudinally without lifting out of mesh as is necessary with the primitive construction

In all the foregoing types chosen to illustrate principles, we find that to effect any change in velocity ratio, it is necessary to change the radial length of one or both the rotating members connected. Thus in the disk and friction wheel the radial length of the working part of the disk is changed with the shifting of the friction wheel across its face; in the taper cone pulleys the working radial lengths of both the driving and driven member change with the shifting of the belt, and so on throughout the list. But this principle is not universal for it is possible to change the relative rate of rotation by other expedients, as for instance, the hydraulic pump and motor, one or both of which have means for varying the capacity per revolution. If the capacities are the same the rate of rotation will necessarily be the same, but any change one way or the other in either the pump or the motor will change the velocity ratio. It is also possible to change velocity ratio in pure mechanism as for instance in the diagonal rack and pinion illustrated by Prof. MacCord in his Kinematics, or by employing the principle of the guide-bar of a lathe, the inclination of which determines the transverse rate of a rack meshing with a pinion and consequently the rate of rotation of the latter relative to the rate of longitudinal transition. Both these devices can be used for limited movements only, and, therefore, are useless for continuous rotary motion in one direction. Reviewing the foregoing we find that the velocity ratio of rotating members may be changed in the following ways:

1. By changing the relative radial lengths of the surfaces in working contact, as in the disk and friction wheel.

2. By changing the point of application of the belt connecting cone pulleys, either of the stepped or taper form.

3. By changing the throw of ratchet mechanism.

4. By the use of expanding pulleys.

5. With the crown gear having multiple sets of concentric teeth.

6. By the use of the back gear either in connection with cone pulleys or without.

7. With cones of gears, with means for locking one and tightening another. An alternative plan is the use of an intermediate gear provided with means for bringing any two pairs of opposing gears into connection.

* * *

OIL GROOVES AND THE FITTING UP OF BEARINGS.

C. H. BIERBAUM.

The grooves in bearings may be divided into two classes: first, the oil grooves proper, whose function is that of distributing the oil lengthwise in the bearing, and to supply the oil directly for the formation of the film, which are properly called "oil grooves"; secondly, the grooves whose function is that of feeding the oil from the supply to the oil grooves proper; these are "feeders" and are correctly named as such.

The oil grooves should always be parallel with the journal in order to effect a uniform distribution of the oil and the formation of an even and unbroken film; the feeders, if cut in the bearing surface should always be cut at right angles to the journal. Oil grooves should never be cut spirally or obliquely. If the oil does not feed into the bearing properly the cause for the same should be determined. It is quite true that spirally-cut oil grooves produce a relatively free flow of oil through the bearings and this has led to a somewhat general misapprehension as to their value. A large or sufficient quantity of oil flowing through a bearing does not indicate that the bearing is being properly lubricated, for the only condition under which oil in a bearing serves its purpose is when it exists in the form of a film between the bearing surfaces, keeping them separated, and offering a fluid friction surface instead of allowing metallic contact. The natural tendency for the oil after it is first brought in contact with the journal or bearing is to form a film over its entire surface and to adhere to it tenaciously. One of the causes for the destruction of this film of oil is an excessive pressure per unit of area. This may be due to a defective design, in that an insufficient bearing surface has been allowed, or it may be due to improperly fitted surfaces producing excessive pressure on "high spots." Whichever the carse may be, under these conditions, no improvement can be made by cutting away necessary bearing surface for an increased capacity of oil grooves. Another cause for the destruction of the oil film is that of a sharp scraping edge in contact with the journal, and when this scraping edge makes an oblique or spiral contact with the journal, its destructive effect upon the oil film is all the more severe.

In a reciprocating bearing, or one in which the thrust is exerted in alternately opposite directions, the oil film should be restored on one side of the bearing while the pressure is being exerted upon the other For this reason the location of the oil groove should be fully considered, in order to best effect this lubrication. The edges of the half-bearings should

bear firmly against each other so that, owing to the elasticity of the bearing and the compression of the oil film on the side of the bearing receiving the thrust, the other side of the bearing may be sufficiently relieved from the journal to permit a complete restoration of the film. In a bearing in which the thrust is constantly and uniformly exerted in one direction, the lubrication is dependent upon the film of oil adhering to the journal by capillary affinity and on being carried around with the same. Other conditions being the same, the pressure per unit of area of this bearing surface must, therefore, be less than that permissible in reciprocating bearings.

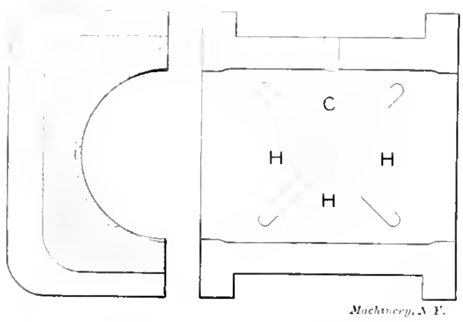


Fig. 1. The Common but Wrong Arrangement of Oil Grooves.

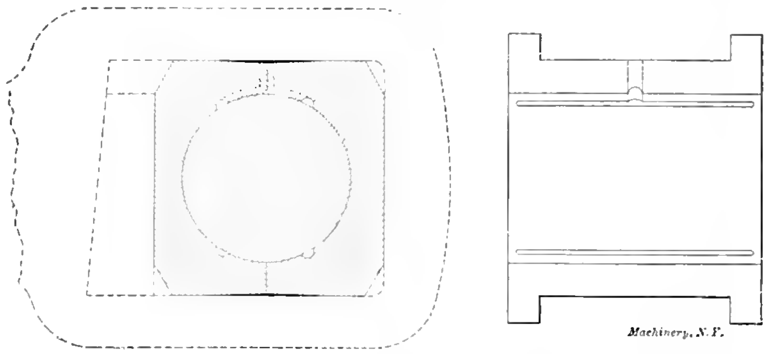


Fig. 2. Correct Arrangement for Bearings of a Horizontal Connecting Rod.

Oils differ as to amount of capillary affinity they have for metallic surfaces, and naturally, the greater this affinity the more persistent will be this film of oil.

Oil grooves, in a measure, may be considered as a necessary evil, whose function is to supply the oil for the film; but after that is done and a perfect film is produced, the conditions would then be improved if no oil grooves existed into which this film could be squeezed. The larger the area of oil film free from grooves or cavities, the greater pressure per unit of area can this film resist without being squeezed out. The idea, therefore, is to locate the oil grooves so as to make them effective in restoring the film at each revolution, and at the same time not have them appear in that part of the bearing surface receiving the maximum thrust.

Fig. 1 represents the old-fashioned bearing with its chamfer and cross oil grooves, assuming the direction of rubbing surfaces from *C* to *H*. This construction cannot be criticised too severely. Three of these areas marked *H* contained within the angles of the intersecting grooves, are poorly lubricated, leaving one area, marked *C*, as the only properly lubricated one. Experiments show that if a thermometer bulb is brought in immediate contact with the bearing surface at different points, the area indicated by *C* would be cool as compared with those marked *H*. The latter show heating due to imperfect lubrication. This is the case with every area of bearing surface lying immediately beyond an oblique groove, and for this reason they should always be avoided.

Fig. 2 represents a crankpin or crosshead bearing for a horizontal connecting rod properly grooved and fitted. The two oil grooves above and the two below the pin are placed symmetrically in the half-bearings, a distance apart equal to one-half the diameter of the pin. The two upper grooves in both half-bearings are connected by feeders, fed directly from the oil cup. Each bearing should be relieved on its upper and lower sides in a manner shown by the upper and lower heavy line. The corners of the half-bearings should be cut away to the extent shown, leaving an area equal to the projection of the crankpin. This construction allows the bearings to become heated and expand appreciably without producing a binding action upon the crankpin.

Fig. 3 represents a crank bearing lubricated through the center of the pin. The two oil grooves in the crankpin should be placed diameterically opposite each other so that their plane makes an angle of 45 degrees with the plane of the crank and shaft. The angle of the two planes should be rotated 90 degrees, if the direction of rotation is opposite from that shown by the arrow in the illustration. In this bearing the same as in Fig. 2 the corners should be cut away and the bearings should be relieved on their sides. For a crosshead pin bearing oiled through the center of the pin the same system of oil grooves as shown in Fig. 2 should be used. The hole drilled through the crosshead pin should be at right angles to the piston rod instead of at 45 degrees, as shown in Fig. 3.

Fig. 4 represents a crankpin bearing for a vertical connecting rod. The same general principle of oil grooving as in the preceding two figures is adhered to, in that 85 per cent of the projected area of bearing surface, in the center of the bearing, is free from grooves, and at the same time offering ample facilities for lubrication. The details of the feeders may vary considerably, depending upon the special construction and design of the other parts; but the principle of avoiding the placing of oil grooves in the line of maximum thrust should always be considered in fitting up bearings.

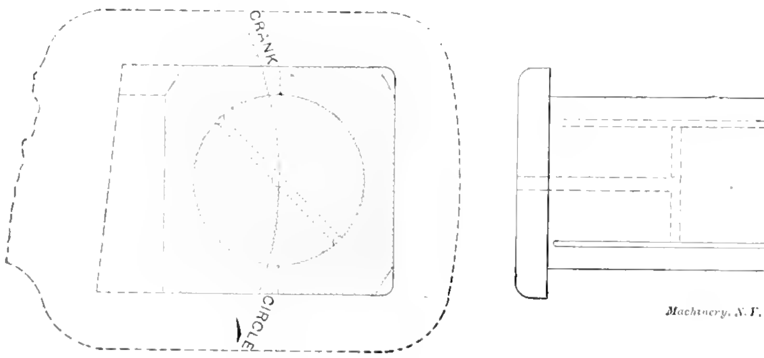


Fig. 3. Showing Distribution of Oil from Center of Crank Pin.

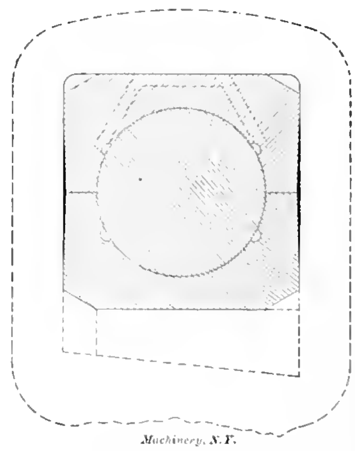


Fig. 4. Crank-pin Bearing with Oil Grooves for a Vertical Rod.

It is sometimes found desirable to vent the oil grooves at the ends of the bearings by drilling holes through the bearing. This produces a freer flow of oil, thus doing away with air cushioning, but spiral or oblique oil grooves for this purpose should never be resorted to.

* * *

The first large war vessel to be equipped with turbine engines, we believe, is the cruiser *Amethyst* of the British Navy. This vessel, which was recently completed, developed a speed of 23½ knots over a measured course on the Tyne. Her gun equipment consists of twelve 4-inch and eight 3-pounder rapid firers; the cost of the vessel is about $1,150,000.

NEW WORKS OF THE INGERSOLL-SERGEANT DRILL CO.

A LARGE PLANT, COMPLETE FROM OFFICE BUILDING TO FOUNDRY, WITH MANY FEATURES OF INTEREST.

The Ingersoll-Sergeant Drill Co. have nearly completed extensive new works at Phillipsburg, N. J., for the manufacture of air compressors, rock drills, and other compressed air apparatus. The business of this company has grown so rapidly and now includes so great a variety of machinery, that the works at Easton, Pa., where their manufacturing has been carried on, have been outgrown, and some two years ago work was commenced on a new plant at Phillipsburg, N. J., which is situated across the Delaware river from Easton.

The site of the old plant is on a bank of the Lehigh River at Easton, and although it is a large tract it is now so covered by the buildings of the plant as to afford no opportunity for future growth. While most of the [illegible] modern, it was thought best to arrange for [illegible] ment of the plant, should this seem necessa[illegible] by erecting new works, complete in every respe[illegible] building to foundry, on a location where there wo[illegible] opportunity for future development. The manufac[illegible] drills, which forms an important part of the [illegible] the original business of the company, is [illegible] the new works. The more important part of [illegible] pressor work is now being transferred to the new p[illegible] rapidly as possible. For the present the smaller air compressors will still be manufactured at Easton, as well as the pneumatic tools, although there may be provision for the manufacture of both at the Phillipsburg works at a later time.

The layout of the new plant and the design of the buildings are the result of a great deal of investigation and study with the view of adapting them to the wide variety of products man[illegible]

Fig. 1. Exterior of Foundry from the Elevated Land at rear of Foundry

Fig. 2. Interior of New Foundry of Ingersoll-Sergeant D[illegible] Co.

factured and also to meet the difficult problem of future growth without disturbing the orderly sequence of the work passing through the factory. In designing the plant, also, there were a number of engineering problems of considerable magnitude to be met, owing in part to location and in part to the great area covered by the buildings, and these have been solved in a novel and original manner, adding much to the interest of the plant from an engineering standpoint.

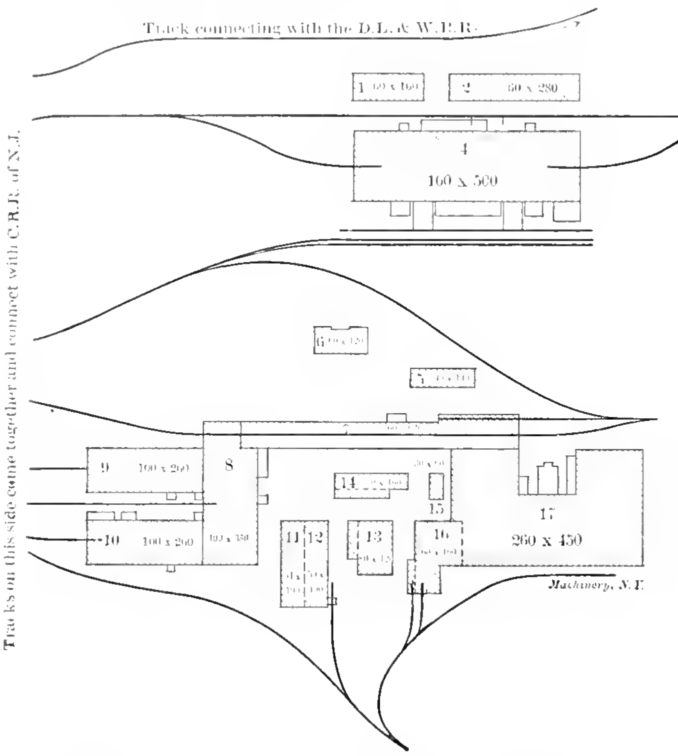


Fig. 3. Plan of New Works of Ingersoll-Sergeant Drill Co.

1. Pattern Shop.
2. Pattern Storage Building.
3. Casting Cleaning Building.
4. Foundry.
5. Carpenter Shop.
6. Office Building.
7. Warehouse and Shipping Department.
8. Air Compressor Erecting Shop.
9 and 10. Compressor Machine Shops.
11 and 12. Power Plant.
13. Blacksmith Shop.
14. Steel Treating Department.
15. Rock Drill Testing Department.
16. Receiving Department.
17. Rock Drill Manufacturing Shop.

will soon be completed. Its other advantages were so great that it was thought best to incur the expense necessary to provide a water supply and a subsidiary company, called the Lopatcong Water Co., was formed for the purpose. A dam 2,000 feet long was built across a river basin some 4½ miles away, forming a storage reservoir over 350 feet above the level of the works. The water flows by gravity to another reservoir at a less elevation, but sufficient to give a pressure of 100 pounds per square inch at the works. The total storage capacity of the two reservoirs is 33,000,000 gallons.

In Fig. 3 is a plan of the works, with a list of the buildings, and in Fig. 6 a perspective view. In the foreground are the foundry, pattern shop and pattern storage buildings, indicated respectively by numbers 4, 1 and 2 at the top of the plan view. Directly back of the foundry and on higher ground, is the office building, No. 6, and back of that the large group of buildings, arranged around three sides of a hollow square, where the machine work is done. On one side of the square are three buildings, 8, 9 and 10, for the manufacture of air compressors. Building 8 is the highest of the group and is the compressor erecting shop, while buildings 9 and 10, connecting with it are the compressor machine shops. It will be observed that buildings 8, 9 and 10 can be indefinitely extended, or if preferred several structures similar to 9 and 10 could be added, should the erecting shop, No. 8, be lengthened.

On the opposite side of the square is an immense one-story shop, with saw-tooth roof, where the rock drills are manufactured. It is generally admitted that this style of shop has no superior for medium and light work, and we have here in contrast, on the two sides of the square, two structures of entirely different design, but each adapted to the class of work for which it is intended. The practice of designing the different parts of a plant to accommodate the work, instead of trying to adapt the work to the plant, is coming to be a prevailing one, and there is here one of the best illustrations of this advanced idea to be found anywhere.

The third side of the square is occupied by a long warehouse, where the finished machines are stored and from which they are shipped. The warehouse can be extended at either end and it will be noted that the rock-drill shop can be added to in any of three directions.

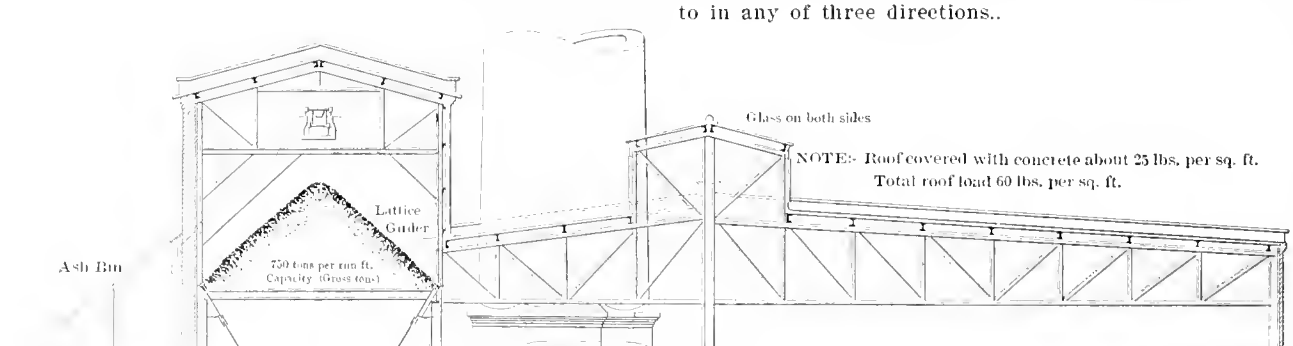


Fig. 4. Cross Section of Engine and Boiler Rooms.

Not the least of these problems was that of water supply. The site of the new plant is an ideal one except for the lack of a natural water supply. The tract of land is a plateau of 200 acres, so situated that two railroad connections are easily secured, and trolley connections with Phillipsburg and Easton

In the center of the main group are several buildings, the larger one of which is the power plant, marked 11 and 12. No. 13 is the blacksmith shop, No. 14 the steel treating department, and No. 15 a building where rock drills are tested before shipping. The power plant, it should be noted, is cen-

trally located, and will remain so, whatever additions to the works may in future be made, and moreover the power-plant buildings, as well as the others in the hollow square, can be extended sufficiently, probably, to meet any requirements that may be made.

An important feature of the works is the track facilities for transferring material. There are over four miles of standard-gauge track in the yards and the company own their own locomotives and cars. There are, besides, narrow-gauge "industrial railways," for hand cars, connecting the different buildings or parts of buildings.

Referring now to the buildings more in detail, we have first what may be called the foundry group, consisting of the foundry, pattern shop, pattern storage and the casting cleaning building. This group is situated a few feet below the level of the other buildings of the plant, which is an advantage because of the facility with which the pig iron, coke, etc., can be carried to the charging floors for the four cupolas of the foundry.

In Fig. 7 is a cross-section of this group, and in Fig. 8 a plan of the foundry. Starting at the right, in Fig. 7, we find a series of storage bins located under the brow of the hill. These bins are of concrete construction with concrete retaining walls. A track running across the top of the bins allows material to be dumped into any of them or to be deposited on top where it can be taken across one of the two bridges connecting this elevation with the charging floors. The foundry itself, an exterior and interior view of which is given in Figs. 1 and 2, is of steel construction, built with three bays, all served by traveling cranes. The central bay, where the heavier work is done, has the unusually wide span of 65 feet and a clear head room of 46 feet under the roof trusses. At the extreme left in Fig. 7 is indicated the location of the pattern shop and pattern storage building, with a yard between this building and the foundry served both by a standard gauge track and a traveling crane. This yard is a much appreciated part of the foundry arrangement. It affords flask storage and all the flasks are readily accessible because of the crane service. A view of the yard appears in Fig. 11.

The brass foundry is in a separate wing of the iron foundry, projecting from the main building and is fitted with Schwartz brass furnaces. In the iron foundry there are two 86-inch cupolas, one 78-inch and one 68-inch, provided with blast by motor driven blowers.

In cleaning castings, a sand blast is employed in connection with rattling instead of the pickling process and [illegible] blast makes a great deal of dirt and dust a separate [illegible] was built some distance from the foundry for this purpose. There are here two sand blast rooms where the larger work is cleaned and one or more of the rattlers for the smaller work are also fitted with a sand blast. An exhaust arrangement is used to draw the dust from this building and deposit it some distance away.

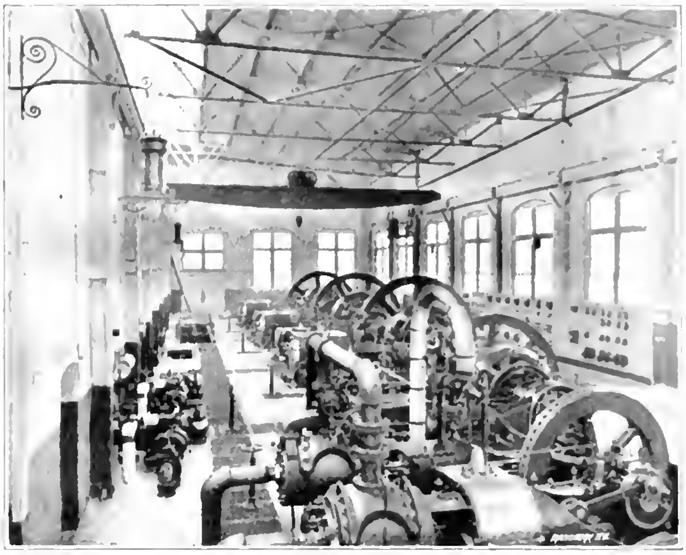


Fig. 5. Interior of Engine Room—Compressors in Foreground, Turbine Pumps at the Left

The excellent track facilities by which the different buildings of the plant are connected make it perfectly easy to transfer the castings to the cleaning building and then carry them around to the receiving department of the machine shop, (building No. 16), whereas if dependence had to be placed upon tram-cars operated by employees, this arrangement would not be so convenient.

The pattern storage building is of mill construction, three stories high, protected by automatic extinguishers. It is served by hydraulic elevator, running in a fire-proof well and the building is divided into seven sections by fireproof walls which extend two feet above the roof. These features and others, such as self-closing doors, render the building prac-

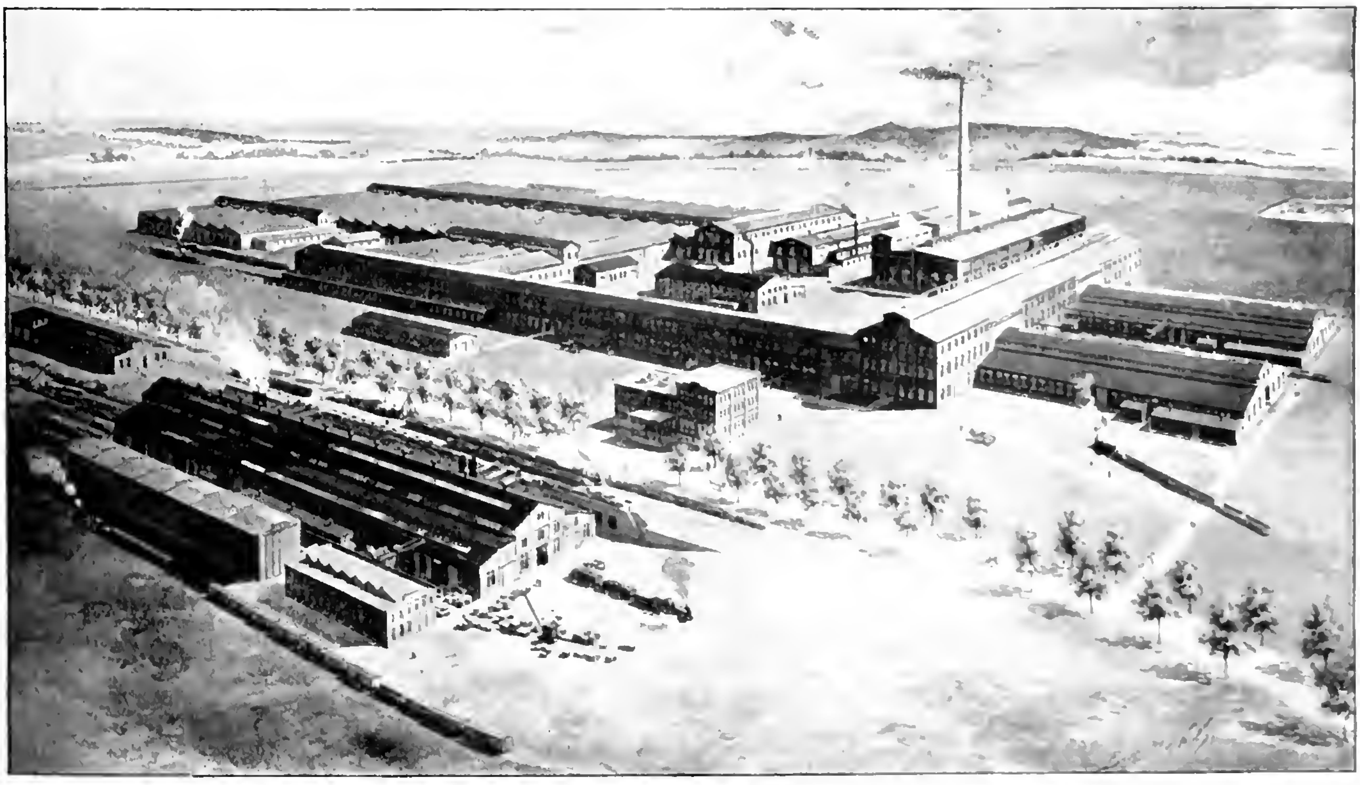


Fig. 6. The New Plant of the Ingersoll-Sergeant Drill Company at Phillipsburg, N. J.

tically fire-proof and assure, in any case, that the damage from fire would be very slight and confined to a small area.

The pattern shop is a two-story building lighted partly from the side and partly by saw-tooth roof.

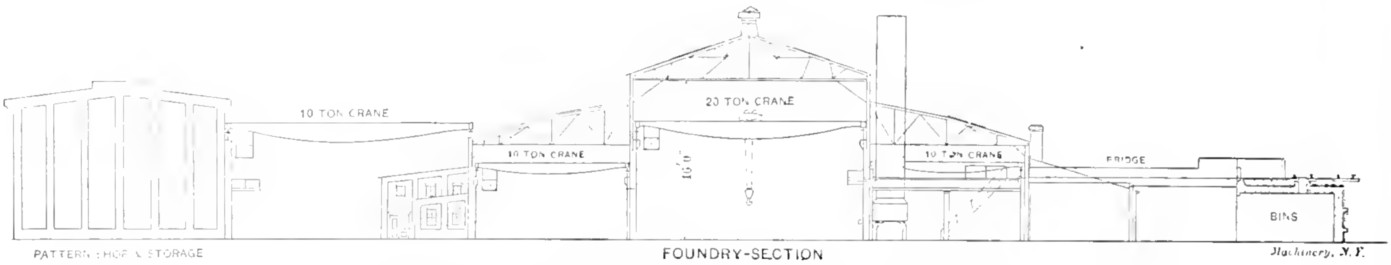


Fig. 7. Cross Section of the Foundry Group of Buildings.

As will be seen in Figs. 4 and 5, the power plant is of the usual modern type of construction, with parallel boiler and engine rooms, separated by a fire wall. The boiler installation consists of six Stirling water tube boilers, aggregating

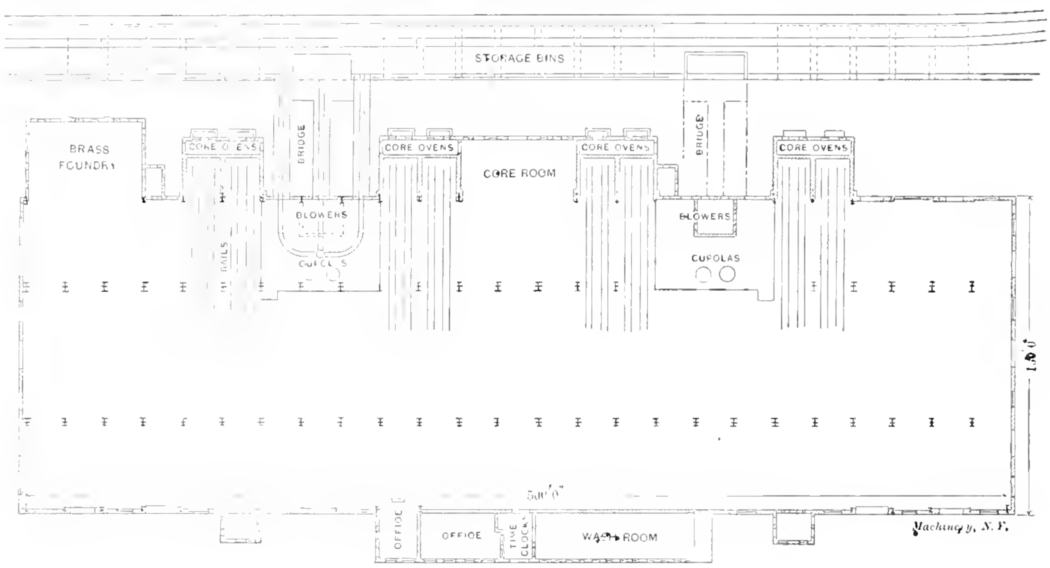


Fig. 8. Plan of Foundry.

1,500 horse power, fitted with Roney mechanical stokers. The boiler room is equipped with overhead storage bins, served by a conveyor, which is also used for carrying ashes from the pit

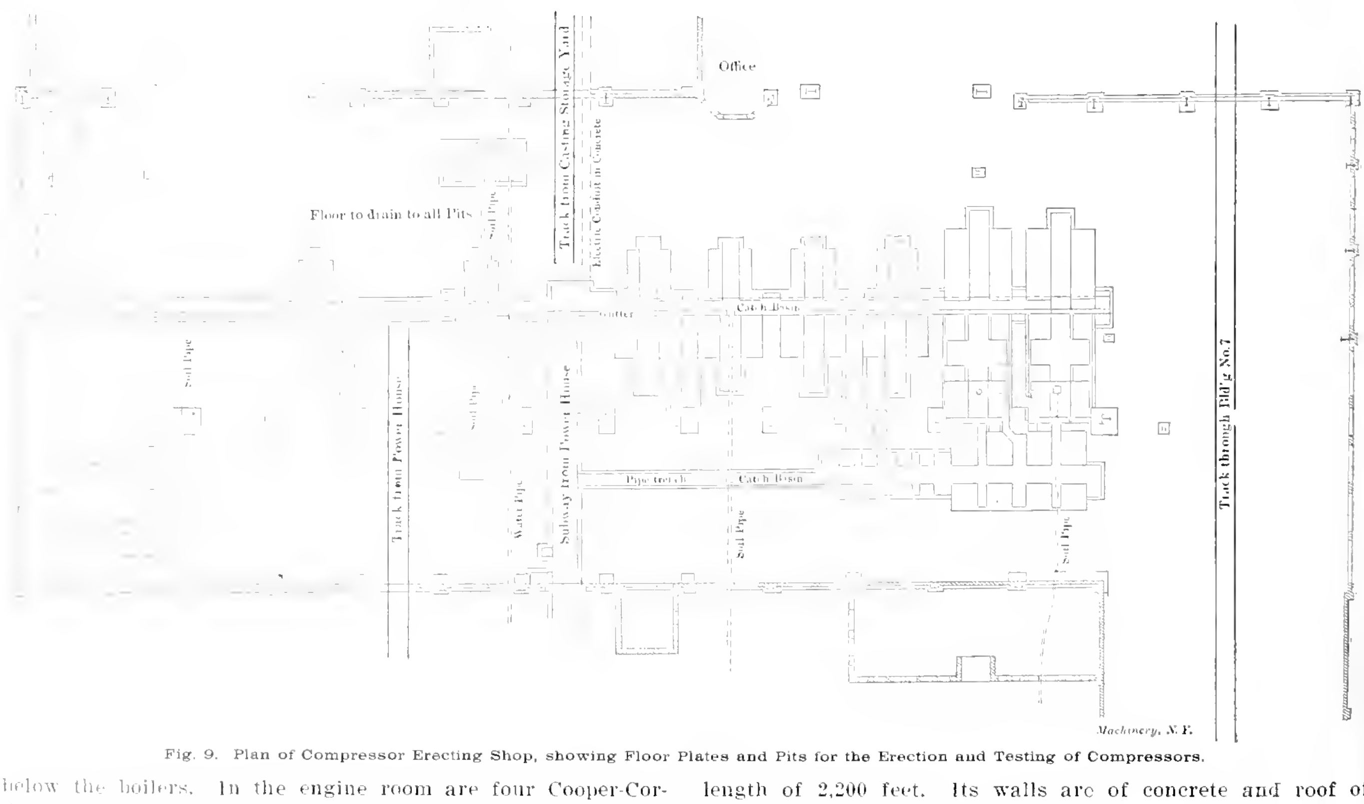
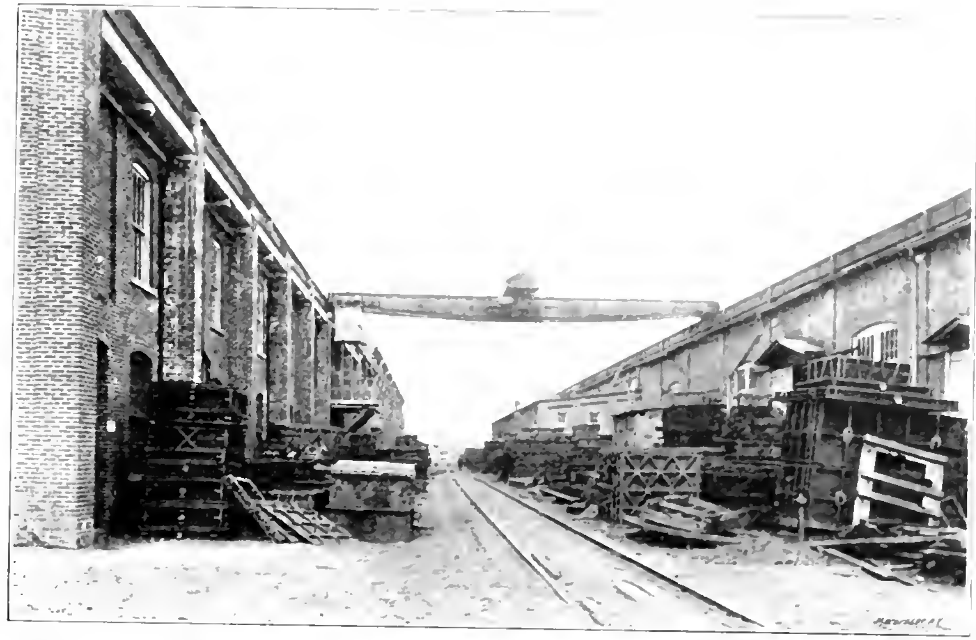


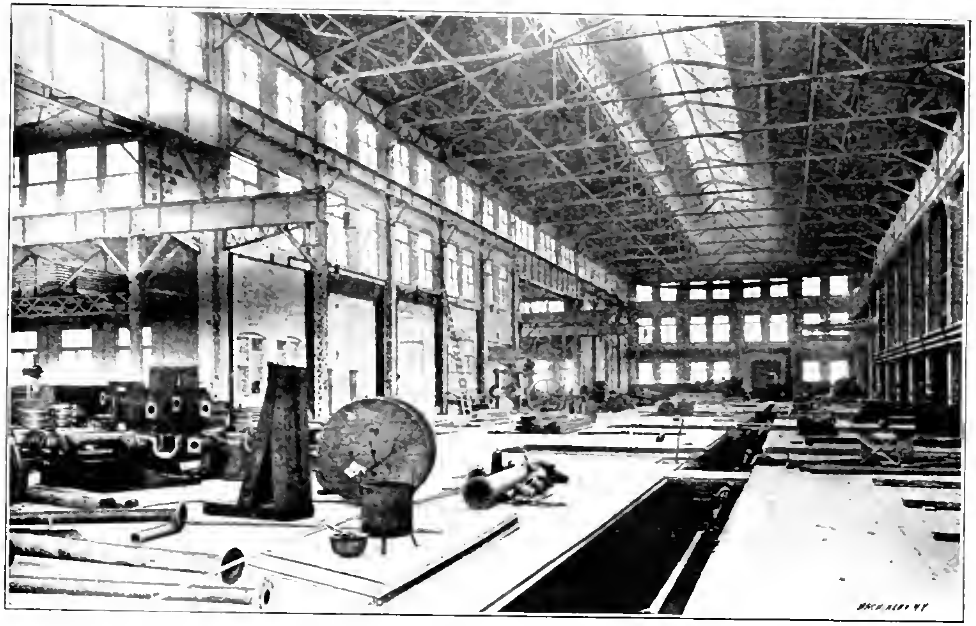
Fig. 9. Plan of Compressor Erecting Shop, showing Floor Plates and Pits for the Erection and Testing of Compressors.

below the boilers. In the engine room are four Cooper-Corliss cross-compound engines, direct-connected to Crocker-Wheeler generators, three of 300 K. W. capacity and one of 100 K. W. capacity. There are also two steam-driven Ingersoll-Sergeant air compressors installed, which supply air under two different pressures for distribution. In space reserved in the engine room there are foundations and pits for mounting steam-driven air compressors for duty tests, where they may readily be connected up to a condenser.

A feature of the power distribution is a tunnel extending from the power house to the different buildings, for carrying the power and lighting mains, the high and low pressure air mains, the pipes for the heating system, water pipes, etc. The tunnel is six feet square and its various branches aggregate a length of 2,200 feet. Its walls are of concrete and roof of reinforced concrete.

All of the factory buildings are heated by the Evans system





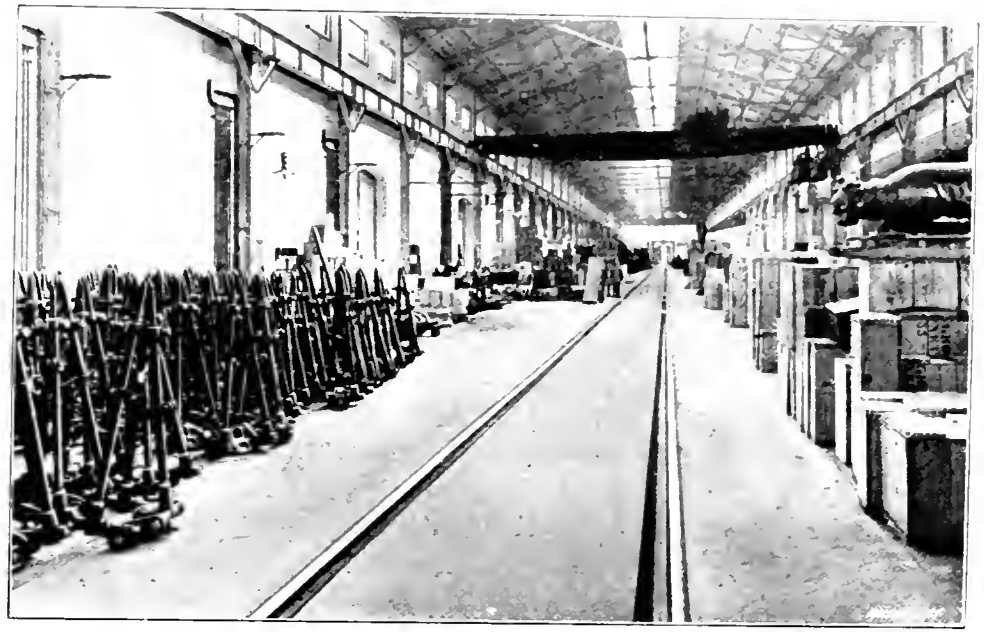


Fig 10. Concrete Storage Bins. The top Bins are level with Foundry Charging Floors and connected with them by the two Bridges shown.

Fig. 12. Interior of Compressor Erecting Shop, showing Testing Pits and Crane Tracks extending from the two Manufacturing Shops.

Fig 11. Flask Yard between Foundry and Pattern Buildings. This yard is served by Traveling Crane and a Broad-gage Track.

Fig. 13. Interior of Warehouse and Shipping Room connecting Compressor and Rock Drill Departments.

of hot water heating by forced circulation, installed by Evans, Almirall & Co., New York. The heating throughout is by means of direct radiation. The pipe coils are built up and attached to the walls, columns and overhead girders, and connected up either in multiple or parallel as circumstances

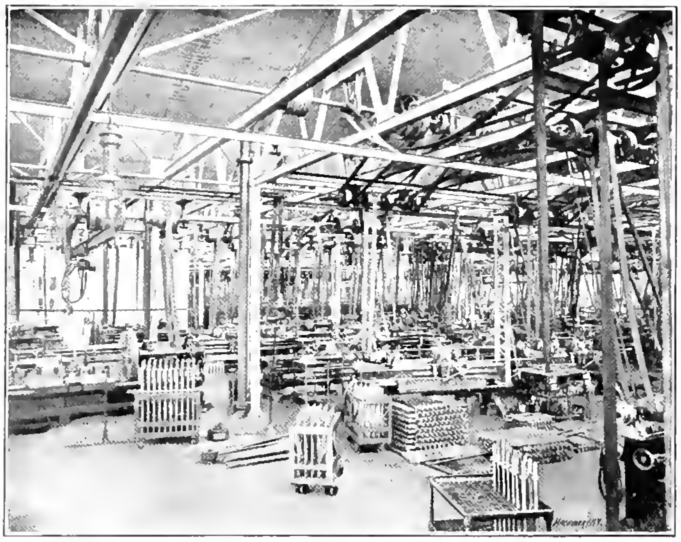


Fig. 14. Interior of Rock Drill Shop showing the Superior Lighting.

require. The most interesting thing about the installation of the heating system is the arrangement of the heaters and pumps in the power house and the method of using the exhaust steam from the engines when they are running either condensing or non-condensing. There are three tubular heaters similar in construction to that of an ordinary closed feed water heater. Two of these are arranged for use in connection with the exhaust steam from the engine and one of them is arranged for use in connection with live steam, the latter intended primarily for use on holidays and Sundays, when there is comparatively little exhaust steam available, or for nighttimes under the same conditions.

There are two main exhaust pipes, one of which is the free exhaust and leads directly to the atmosphere and the other is the exhaust to the condensers. On the individual exhaust connections from each engine, there is a Schutte free relief valve by means of which, in case the vacuum should break, any engine would automatically exhaust to the free air pipe, and thus prevent possibility of any accident thereto.

The condensing exhaust main is connected first to the two exhaust heaters referred to above, for the heating system and from thence to the condenser. The arrangement of the exhaust piping is such that the steam may be led either through these heaters or it may be by-passed around either or both, direct to the condenser. Under ordinary conditions the exhaust steam passes through the exhaust heaters first, and from thence, if any steam is left, to the condenser.

By this method, it is possible to vary the degree of the vacuum by running the condenser pump more rapidly or more slowly, and thus vary the temperature of the exhaust steam while still obtaining the economical effect of a condensing engine, due to the vacuum carried. The circulating water of the heating system is warmed accordingly, and can be carried at a temperature within 10 degrees of that of the steam. By this method the temperature of the water is varied to suit the outside temperature conditions. In extreme cold weather the engine units can be run non-condensing and the water heated to its maximum temperature of 200 degrees, but during the earlier winter months, and the early spring months, when some heat is carried a considerable vacuum can be maintained at the engine, and yet the heating accomplished at practically a nominal cost. The water is circulated throughout the mains and coils in the buildings by means of De Laval Steam Turbine units, which are provided in duplicate. No traps or other mechanical appliances whatsoever are required in any building outside of the power house.

The method of variable-speed operation for the machine tools of the plant is that of the four-wire system of the Crocker-Wheeler Co., which has already been fully described in these columns. In the compressor machine shops where the larger tools are located the individual drive is used almost

Fig. 15. It is all in the Point of View. Photograph from top of Chimney during Construction of the Plant.

to the exclusion of group driving. The current is distributed throughout these shops by running the wires in bituminized conduits laid in the cement floor a few inches below the sur-

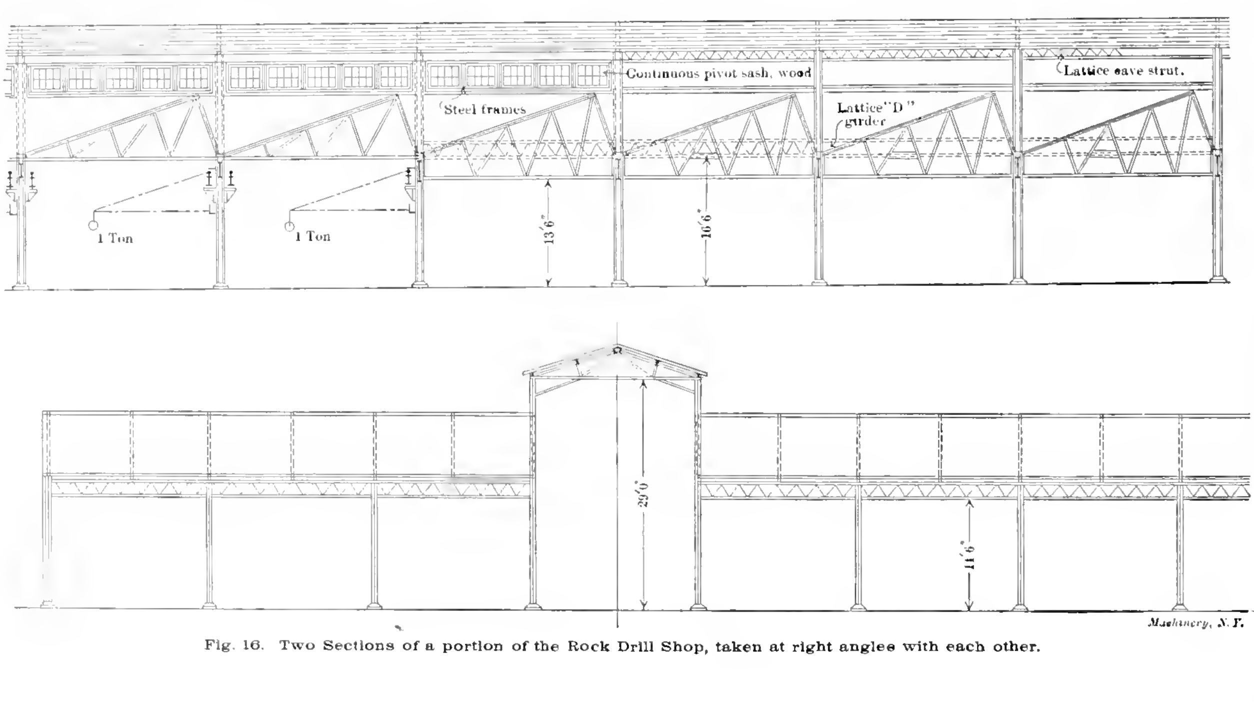


Fig. 16. Two Sections of a portion of the Rock Drill Shop, taken at right angles with each other.

face. Branch conduits run to a point near each column of the different buildings and terminate at floor openings, provided with cover plates, where leaders running to the tools in the immediate vicinity are easily connected.

In the rock drill shop group driving is employed almost to the exclusion of the individual drive. The motors are mounted under the roof and belted to the line shafting as shown in Fig. 17. The motors are supported on the lower members of the trusses and the line shafting is hung on short channels

ening steel. The oil tempering process is extensively similar to the process employed by large steel works in treating high carbon steel used in gun construction; and, in fact, the same high grade material and advanced methods of tempering are required that are used in preparing the steel for the severe duty required in the coast defense and naval guns.

Building 15, adjoining the rock drill shop, is the testing-out plant for the drills; they are here set up and allowed to pound away on metal anvils and the separation of the

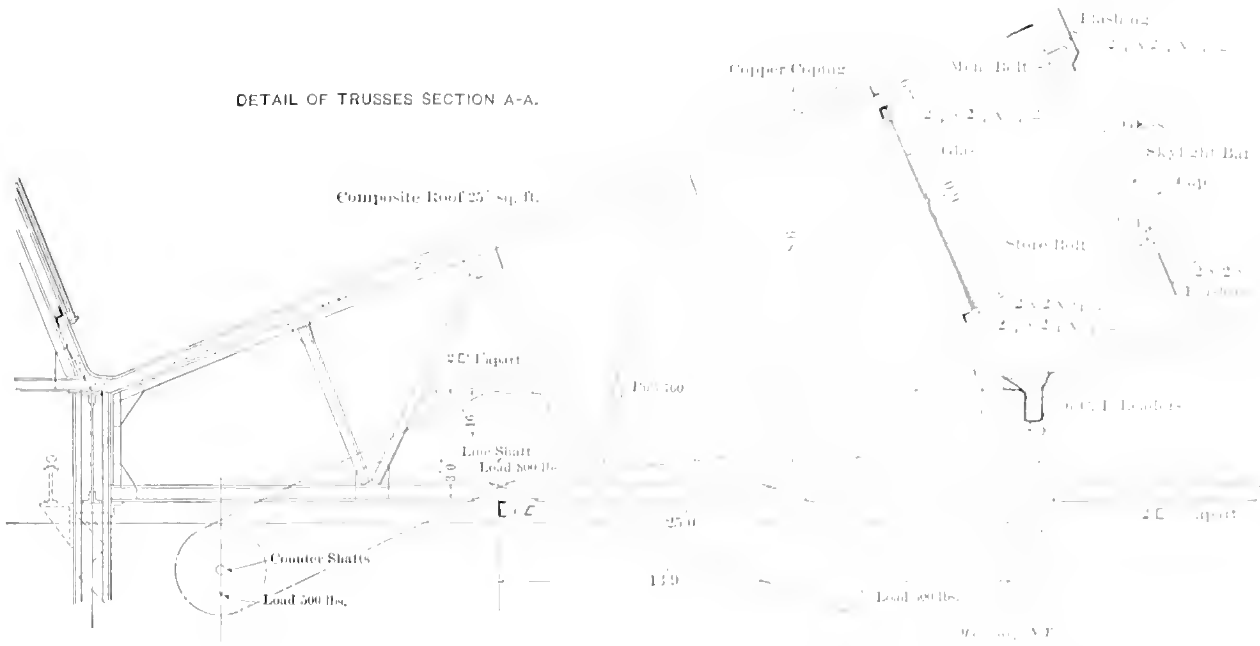


Fig. 17. Details of a Section of Saw-tooth Roof, showing, also, the Arrangement of Motors and Shafting

especially placed for this purpose. Countershafts hung from the lower members of the trusses are placed on each side of the line shaft, thus equalizing the belt pulls.

In Fig. 9 is a floor plan of the compressor erecting shop showing the elaborate foundations and pits that have been built in the floor, for the erection and testing of the air compressors. An interior view of the building appears in Fig. 10, and the piping will be noticed on the right. Near each pit are manifolds through which a compressor may be connected to either the high- or low-pressure air mains and thus compress air into the system instead of wasting it. There are also to be pipe connections leading to reservoirs outside the building in which air may be compressed to very high pressures, where a compressor is designed for special high-pressure duty and is to be tested at high pressure. The foundations of the testing department are laid in concrete.. Pits were dug at intervals and walled up, over which the compressors are to be erected, giving facility of access, opportunity for pipe connections, etc., and on each side of every pit are broad foundations on top of which are iron floor plates carefully leveled and grouted in.

The blacksmith shop has a complete equipment for producing forgings which are required in large numbers for the rock drill department, and there are also three hammers of about 2,500 pounds capacity for forging considerably heavier work. There are several drop presses with furnaces of the down-draft type.. A feature of the blacksmith shop is an auxiliary boiler receiving heat from the waste gases of the furnaces and generating steam for operating the hammers. The shop is served by a number of jib cranes and is well lighted and kept free from smoke by the exhaust system connecting with the furnaces.

The peculiarly severe duty required of rock drills makes it necessary to employ steel as free from internal strain as possible for all of the reciprocating parts. A rock drill is a portable machine made as light as is consistent with strength and durability which must be secured by employing materials of the very highest grade and treated by the most scientific processes. A large steel treating department has been equipped for this work containing annealing furnaces, gas hardening furnaces and oil tanks, etc., for annealing, tempering and hard-

department from the main structure relieves the employees of the latter from the annoyance of the jar due to the operation of the drills.

* * *

A paper read by S. F. Seager before the Michigan Engineering Society, January 11, 1905, on the Pintsch suction gas producer was designed to show the advantage of a suction gas producer over the older type of apparatus. Anthracite, coke or bituminous coal can be used as the fuel, the first named giving the cheapest production of gas. When the fire is first started a small blower, which is run by hand or foot power for units up to 150 horse power, is used. When the temperature has become high enough for proper gas generation, the gas is admitted to the engine and the suction stroke of the engine furnishes the draft through the fire. The heat of the CO gas is nearly all taken up in forming the steam which gives up its hydrogen to form the producer gas, and but little energy is lost in the scrubber which finishes the cooling process and extracts the dust particles. The gas next passes through the cleaner, which is filled with sawdust, when all the remaining impurities are extracted, the claim being made that where anthracite is used in the generator, an engine can be run six months without needing cleaning. In connection with the apparatus the engine is equipped with governor control on the admission of both air and gas. The claimed advantages of the suction gas producer over the pressure producer are that owing to the partial vacuum which exists in every part of the apparatus there is no leakage of gas, clinkers and ashes can be removed at any time during the working, and only the actual amount of gas used by the engine is generated. Only a few of these plants have so far been installed in this country, but they are coming into common use in Belgium and Germany, where the system originated. Tests have shown that for units of 50 horse power, 1 pound of anthracite will produce one horse-power hour, and with larger units this can be cut down to 0.75 or 0.80 pound.

* * *

Statistics received by the Department of Commerce and Labor, through its Bureau of Statistics, indicate that the world's output of coal in 1903 was 864,000,000 long tons, of which the United States produced 319,000,000 tons

NOVEL MAGNETIC CLUTCHING AND SPEED ACCELERATING DEVICES OF THE CUTLER-HAMMER MFG. CO.

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., has been carrying on experiments for several years in the development of magnetic couplings and accelerators. These efforts have been successful, and the Cutler-Hammer Clutch Co. has now been organized for the manufacture and sale of the apparatus designed along these lines.

The Cutler-Hammer magnetic clutch is a device applicable wherever the shafts to be coupled are at rest or both are running at the same speed when the coupling takes place. They can also be used to cut out a machine or section of shaft when in rotation. The magnetic speed accelerators fulfill the functions of the ordinary friction clutch, and in addition have a much wider application. They are used, generally speaking, for connecting a shaft to be driven to a driving shaft when the driven shaft is at rest or is rotating at a speed different

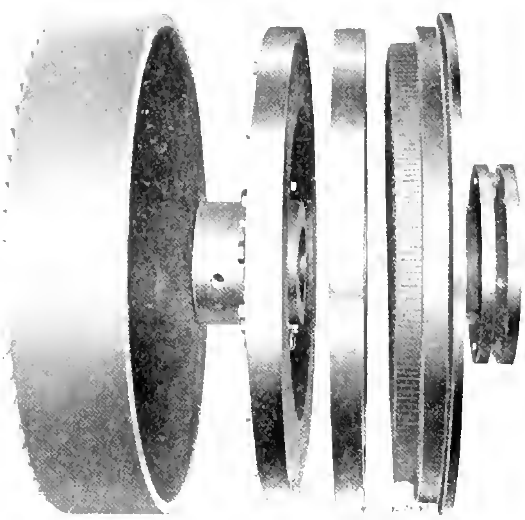


Fig. 1. Parte of Magnetic Accelerator in their Proper Relation.

from that of the driving shaft. This coupling is followed by a smooth acceleration of the speed of the driven shaft, up to synchronism with the driving shaft, or, if desired, to some predetermined speed less than that of the driving shaft. This result is attained by the production of a torque having two components, one due to friction and one due to eddy currents induced in the armature plates by the magnetism of the field, which is especially constructed to secure this result. The induction component of the torque is a maximum at the moment of starting, dropping off as the driven member attains speed. At the same time the torque due to friction, which remains sensibly constant during the acceleration, increases suddenly as the driven shaft approaches full speed, on account of the change from the "friction of motion" to the "friction of rest." Thus an increased torque is produced at the two points where it is most needed in practice, at the time of starting the driven member from rest, and at the time of bringing the driven part to full speed. When the accelerator is used as a speed changing device the torque due to friction is largely eliminated by mechanical or electromagnetic means.

The parts of the magnetic clutch, first mentioned, are shown in Fig. 2. They consist of two cast steel rings, carried on steel plate webs which are bolted to the shafts to be coupled. One of these rings, called the field ring, has an annular slot in which the magnetizing coil is secured; the other, which acts as the armature or keeper, is so mounted as to be separated from the field member, when the coupling is not energized, by an air gap of from 1-16 to 3-16 of an inch. The spring of the steel plate webs carrying the field and armature allow these members to spring together when the coil circuit is closed, the magnetism induced holding them by a strong pressure. When the circuit is interrupted the spring of the plates separates the surfaces. This clutch is shown in section, mounted on the two shafts, in Fig. 4.

A sectional view of the magnetic accelerator, mounted in position, is shown in Fig. 3. The parts of the accelerator, placed in proper relation ready to be assembled, are shown in Fig. 1. These are, from left to right, the oil casing, field, magnetizing coil, and the back plate with flange to which the oil casing is attached. It is seen that this arrangement is opposite from that of Fig. 3.

The field is made up of the back plate, outer and inner field-rings, magnetizing coil and contact rings. The back plate, shown to the left of Fig. 3, is a cast steel plate, with a hub

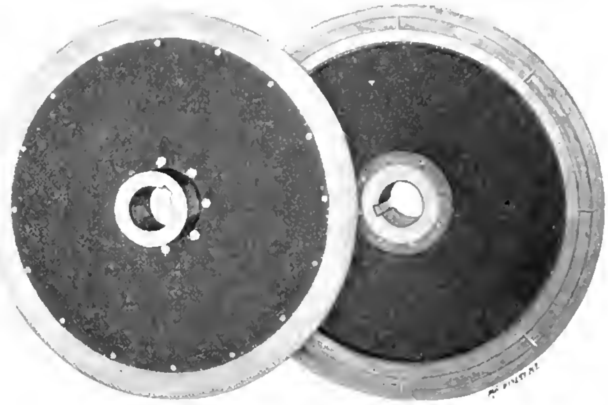
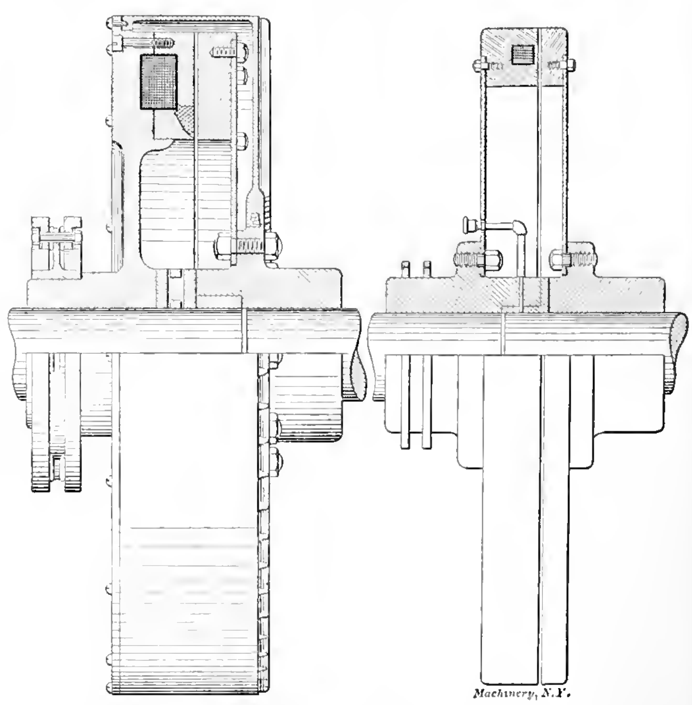


Fig. 2 Parts of Magnetic Clutch.

which is bored and key-seated to receive the shaft or sleeve on which the device is to be mounted. The plate has an annular groove which carries the magnetizing coil; the contact rings, to which the coil terminals are attached, being mounted on the hub. The back plate is faced off to receive the field rings. The latter are cast steel rings having radially projecting poles. When assembled, the polar projections of the outer and inner rings intermesh, the inter-polar spaces being filled with some non-magnetic metal, such as babbitt metal. When thus assembled and finished the inner and outer field rings with polar projections separated by babbitt form a continuous surface for the bearing face. When mounted on the back plate they serve to protect the magnetizing coil, which is completely enclosed, though not surrounded by a complete magnetic circuit.



Figs. 3 and 4 Half-sectional Views of Magnetic Accelerator and Clutch.

The appearance of the field castings, in the rough and after being babbitted, is shown by the middle and right hand figures in Fig. 5, while the back plate with the magnetizing coil is shown in the left hand figure.

The effect of this construction is, the coil being entirely surrounded by iron, that the current through the winding and consequently the strength of the magnetic field in the inducing or field member, is retarded, when the circuit through the coil is completed, on account of the large amount of induction. This prevents the sudden acceleration of the driven member.

By the radial overlapping of the magnet winding by the polar faces, the entire surface of the clutch is utilized as a friction surface. The magnetic effect of the disposition of the polar surfaces shown is to cause the lines of force passing from the polar surfaces to the armature to move in substantially tangential directions, the eddy currents induced in the armature being thus so disposed that the reacting lines of force produced thereby are tangential. Thus the maximum turning effort is secured, the tangential components of the lines of force being those which tend to produce rotation. Furthermore, this disposition of the polar surfaces aids in causing the members to quickly separate when the coil windings are deprived of current, as by the arrangement of the polar surfaces, the magnetic field is divided into a large number of individual magnetic circuits, which aid in causing the rapid disappearance of the residual magnetism in the armature.

The armature is a cast-iron plate, adapted to be drawn into engagement with the field when the latter is energized. The mounting of the armature, as shown in Fig. 3, is a novel feature of the accelerator. The armatnre is bolted on the outer circumference of a disk of steel plate, which in turn is bolted to a flange on the hub. The hub may be keyed or loose, but has practically no end play in either case. When the accelerator is energized, the spring of the steel plate allows the armature to move laterally across the slight intervening space, and engage the field. When the circuit is opened the spring of the plate acts to release the clutch. A roller or thrust bearing is provided to maintain the spacing between the faces of accelerators intended for heavy service.

The oil casing is a cast iron shell, bolted to the back plate and enclosing the armature. It is provided with tapped holes for filling and draining, and carries oil for lubricating the faces. The oil also serves the purpose of a cooling medium, absorbing heat and giving it out through the walls of the casing, which is provided with a large number of ribs. These serve the double purpose of increasing the radiating surface and acting as fan blades to increase the circulation of air. The employment of the oil between the armature and magnet member lessens the danger of cutting. It has been found that this use reduces the torque but slightly.

The magnetizing coil is wound of double cotton covered wire, is well insulated, and is securely anchored to prevent shifting. The leads are brought out through insulating bushings, and are of lead encased wire.

In practice these accelerators find their readiest application to that class of service where it is desired to control moderate or large sized units by some form of automatic device, such as a float switch, relay or electrical contact of any kind. For most work they can be thrown directly across the line without danger from shock or jar, as it is practically impossible to produce a sudden jerk with them. In connection with gear trains this device is also used to operate a machine at different speeds, and this arrangement has proven very satisfactory in practice.

The accelerators are easily balanced for much higher speeds than that for which the ordinary clutch is available. A small current suffices to energize the magnetizing coil, two amperes being sufficient to control a 100 H. P. unit at ordinary [illegible] Adjustment for wear is unnecessary on account of the large wearing surfaces. One of these clutches has been in successful operation in the steel plate mill of the Riter-Conley Co., Leetsdale, Pa., for three months, starting a 100 H. P. load over 200 times a day, without need of adjustment.

The design construction and many applications of these accelerators are protected by patents lately issued to the Cutler-Hammer Mfg. Co., covering inventions of Mr. H. H. Cutler, chief engineer of the company. Among the applications patented are a method of power transmission, using a magnetic speed accelerator which possesses the inherent property of gradual acceleration; means for starting synchronous motors under load, and for starting single or polyphase motors under load without disturbing the power factor on the lines. Other patents cover methods of operating trains of cars arranged on the multiple unit plan, so that all the motors may be started, stopped and reversed from any car on the train, and a method of improving the power factor on a line in starting alternating current motors under load, utilizing the controllable inductive and frictional slip of a magnetic accelerator mounted between the motor and its load.

Fig. 5. From Left to Right Back Plate of Magnetic Accelerator with Magnetizing Coil, Field Castings in the Rough, and Field Castings after being Babbitted

* * *

GOLD FROM SEA WATER.

The fact that streams and rivers are continually washing away the earth's surface, and carrying its constituent elements to the oceans, make them great repositories of all the minerals and metals known. Just as surely as the alluvial deposits on certain rivers are gold-bearing, just so sure is it that these rivers have carried into the sea many times the amount of gold found along their beds. Chemical analyses have confirmed this deduction, inasmuch as the average amount of gold found in a ton of sea water is something like 1 grain, worth about 4 cents. This is a small sum but multiplied by the tons of water estimated to be contained in the ocean—60,000,000,000,000—it makes an amount well calculated to stagger the imagination. Many wild and chimerical schemes have been evolved for recovering gold from sea water, most of which were far more successful for drawing gold from the pockets of the investors than from the water. An announcement made in the daily papers of a new process developed abroad, which has the alleged sanction of Sir William Ramsay, has attracted world-wide attention, nevertheless, for it is pretty generally believed that it *is* a possibility to secure some measure of the great amount of gold in sea water. A recent English consular letter refers to a report that a syndicate has acquired favorable sites on the English and Irish coasts for over fifty miles of foreshore. It is explained that it is necessary to acquire foreshore rights in order that the water secured for the new gold separation process shall be as free as possible from river factory contamination.

* * *

The Halifax Dock Yard in Nova Scotia, which was started in 1758 and completed in 1770, has recently been closed and 300 employees dismissed. It will no longer be used as headquarters for the British navy, hence has no further usefulness as a naval repair station.

A PUNCH FOR THE MANUFACTURE OF WASHERS AND SPECIALTIES.

The Krips-Mason Machine Co., Philadelphia, Pa., have placed a machine on the market for the manufacture of washers, armature disks and electric and hardware specialties. The general lines of the machine are those of a punch of substantial construction, and it is intended to be fitted with punches and dies of special design made under the patents of Mr. Joseph M. Mason; but these are easily removed and other punches and dies may be substituted if desired, or the machine may be fitted for shearing. It is thus adapted to a wide range of work and can be made a tool of general utility, so that it can be kept busy in almost any machine shop upon one kind of work or another.

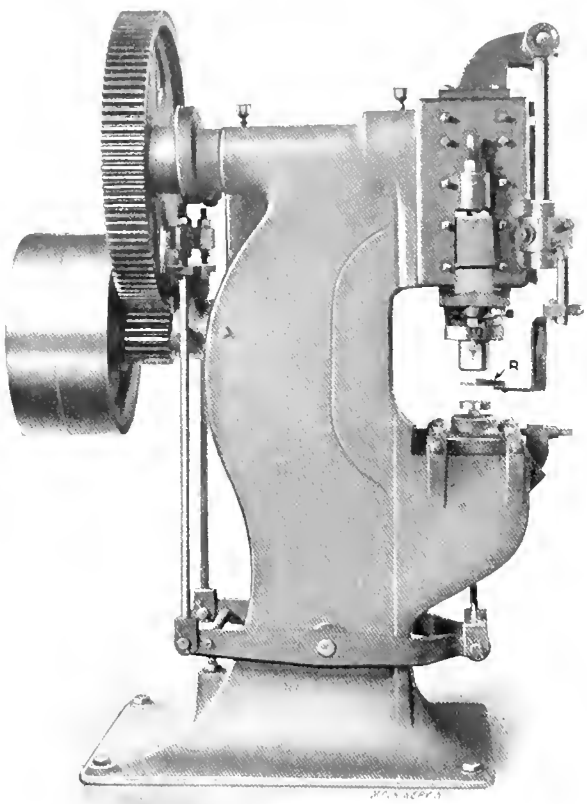


Fig. 1.

The machine was at first intended solely for the manufacture of washers from various materials, but punches and dies, upon the principle of those designed by Mr. Joseph M. Mason for producing washers, have been made for more complicated pieces and operate very successfully and rapidly. The machine cuts and punches at one stroke and may be fitted either with single or multiple dies as desired. In working up scrap metal into washers, however, it is more economical to punch a single washer at a stroke, and any concern using metal plate or sheet metal can work up the scrap in this way and thereby affect a saving. In fact, an important adjunct of the business of the Krips-Mason Co. is the production of washers from scrap metal with their own machines, which they operate both at their own plant and at the plants where the scrap metal is produced. They have recently taken contracts for working up several hundred tons of metal in this way, although their business is primarily that of manufacturing the machine itself.

In Fig. 3 is a sectional view of a multiple die used in punching washers; the head *A* is given a vertical reciprocating motion by the eccentric *B* in the usual manner, and the upper die *C* is bolted to the lower end of the head. A bolster *D* bolted to the frame of the machine carries a series of lower dies *E*, which, in conjunction with the upper die *C*, cuts out the washers. Centrally arranged in each of the openings *F* of the upper die is a punch *G*, which in conjunction with the central opening in the lower die, forms the holes of the washers. The sleeves *H* in the upper die for ejecting the washers from the upper die are fitted with the usual pins to prevent the washers from adhering to them.

The head of the machine is slotted for the bar *K* which rests upon the two vertical pins supported by the flat plate *L* which bears upon the tops of the several sleeves. The punches and dies come together simultaneously and cut the washers at one stroke and upon the return of the die head the bar *K* strikes the two adjustable screws *M* attached to the frame,

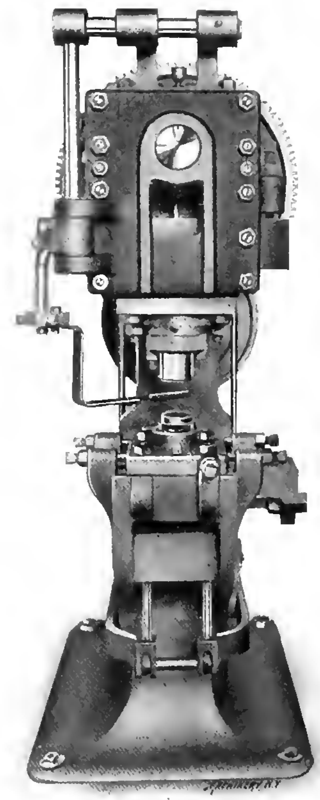


Fig. 2.

and forces out the washers. The stripper plate *N* frees the stock from the lower dies enabling it to be fed along for the next stroke.

In Figs. 1 and 2 will be noted the method of bolting the

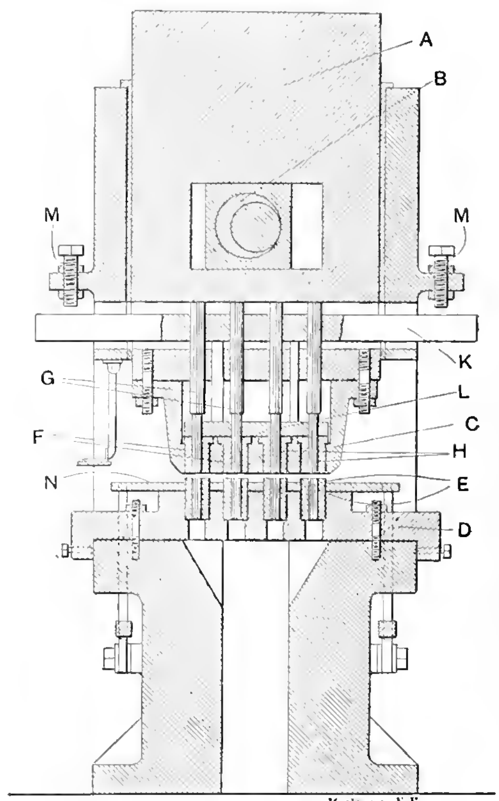


Fig. 3.

upper and lower dies to the machine. The stripper plate for the lower die is operated by the levers at the bottom of the machine which receive their motion from a cam on the shaft with the large gear. A carrier *R*, Fig. 2, swings back and forth in a horizontal plane and carries the washer, when it is forced out of the upper die to a receptacle placed at the side of the machine, where the finished product accumulates.

It is possible for a person to operate the punch without in any way endangering himself, since there is no reason for touching the stock or the finished product at a point anywhere near the dies. The machine is so far automatic that it can be operated by a boy and the several adjustments are easily made. Washers or other metal pieces produced have no burr on their lower edges and are flat and need no rolling after they come from the machine. Owing to the firm manner in which the stock and punches are supported, the machine will produce washers or other pieces from soft material like brass, fibre, leather or paper, as well as from steel or iron plate. It will also punch cold nuts as well as thinner material. Armature disks up to 6 inches in diameter have been successfully produced at one stroke, and much larger sizes are contemplated. At present the machine is regularly built in four sizes, taking work up to 6 inches outside diameter.

* * *

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.

The semi-annual convention of the National Machine Tool Builders' Association was held at Washington, D. C., on April 11th and 12th. There was a good representation of firms and the Bullard Machine Tool Company joined at this session. At the first session the routine business was transacted, reports of committees were read and a paper was presented by W. P. Davis, upon conditions of trade, in which he stated that the foreign demand for large tools is comparatively light, but that orders for small tools are fairly satisfactory. He stated that dealers claim to have had the same amount of business in 1904 as in the previous year, but that sales were made upon a basis of smaller profits. The belief was expressed that after the cessation of hostilities in Manchuria there would be an increased demand in Russia and Japan for machine tools which we should be prepared to take advantage of.

At the succeeding sessions the leading subjects discussed were the conditions of an up-to-date foundry for machine tool manufacture; the acquisition of the world's markets; the question of tariffs and the discrimination against the American manufacturer of machinery; the apprenticeship question; the revision of prices; the motor drive and belt drive for machine tools.

There are few machine tool manufacturers in the country having their own foundry and the question as to whether it is advantageous to the manufacturer to have his own foundry was discussed at some length. The question of the world's markets led to a suggestion that it would be advantageous to train young men especially for traveling abroad to introduce machinery; and that they should learn foreign languages and become familiar with methods of buying and selling in different countries so that they could not only act as salesmen but assist in the preparation of literature to be distributed abroad.

Mr. G. Herbert Condict of the Electro-Dynamic Co., Bayonne, N. J., presented some interesting data upon machine tool driving. In pointing out the advantages of the motor-driven tool, he stated that with the belt drive it had been practically demonstrated that the average loss in the belting and the shafting amounted to at least 50 per cent. of the total power. To substantiate this he cited a number of instances from actual practice, where power determinations of installations had been made. One of these was a plant entirely equipped with individual motor drives in which only ½ the power was required that had been calculated to be necessary in case the shop were to be equipped with the belt drive. Another instance was that of a shop where it was desired to operate only a few tools upon occasion, for which about 25 horse power would be required. An auxiliary engine of 35 horse power was connected up for the work and it was found that the engine would not turn over the shafting, and upon a careful investigation, the transmission machinery was found to absorb 50 per cent. of the power of the main engine. Another case, an extreme one, was where as much as 83 per cent. had been absorbed by the transmission machinery. In electrical transmission, assuming the shop to be operated at say, 75 per cent. of the generator capacity, so that a good efficiency can be obtained from the generator itself, the loss between the engine shaft and the line will be about 6 per cent., the line loss 2 per cent. and the average loss in the motor itself of 17 per cent., assuming it to be an efficient motor. The loss between the motor shaft and the shaft of the tool itself, where a single power of gear or a general drive is used amounts to 5 per cent., so that the total loss between the engine shaft and the tool shaft would be about 28 per cent. Mr. Condict dwelt upon a number of other points and referred briefly to the operation of the interpole motor made by his company.

The subject of the tariff was taken by Mr. Fred A. Geier, who outlined in detail the tariff rates of different countries upon machine tools, and told where and to what extent it might be expected that the rates would increase. At the present time the United States has the advantage of the "most favored nation" clause incorporated in the treaties which we have, at some time or other, concluded with the leading countries. By this clause, if two nations agree upon mutual concessions through the negotiation of a commercial treaty, other countries having treaties may participate in the concessions granted by the two nations in question. This has secured us favorable rates in certain countries, including Russia. In 1901, however, an extra import duty was levied upon Russian sugar to offset a Russian bounty upon exports of sugar, but, in return, Russia has increased the duty on certain products, among them iron, steel, etc. In France two schedules are in effect, a higher and a lower one, and a reciprocity treaty to secure the lower rate on certain American products, among them machine tools, has failed because of the objection by certain manufacturers in this country to the importation of hosiery and jewelry from France as called for by the treaty. Germany, having taken a forward step in manufacturing, is now in a better position than heretofore to supply her own markets, and the tariff is to go into effect in 1906 with heavy duties on foreign products. Also in Austria-Hungary, there is to be a higher rate. Mr. Geier pointed out that the various tariffs are so arranged that concessions can be made to nations desiring to enter into the reciprocity treaty, and that our salvation lay along the lines of an amicable adjustment of treaties, both here and abroad, through reciprocity treaties rather than by attempting to wage warfare against foreign manufacturers.

* * *

INTERESTING PHOTOGRAPHS OF STEAM TURBINE BLADES.

The Westinghouse Machine Co., East Pittsburg, Pa., have recently taken photographs of the interior of the first steam turbine put into practical use in America, this being the first turbine built by them for practical service. The machine was installed in 1899, and has been in continual service for 24 hours a day for a period of over 5 years. The steam supply for this turbine has not been favorable to longevity of service, since the steam has always been excessively wet, owing probably to a long run of steam piping, and it has frequently occurred that creek water had to be put into the boilers, owing to the failure of a steady supply. This water is extremely acid and has so bad an effect upon the turbine that the outer surface of the balancing pistons of the turbine had to be coated with white lead to prevent their corrosion from this cause. Furthermore, owing to the accumulation of sediment carried over when this water was used, the turbine has had to be frequently cleaned by air blasts. In view of these facts it would seem that this turbine was subjected to about as severe a test as a machine could well be put to in practice, and the photographs showing the conditions of the blades are, therefore, of unusual interest as indicating what may be expected in the way of durability with turbines of this type.

In Fig. 1 is a view of a portion of the rotor taken at the low-pressure end where the steam is the most moist and cutting action would be expected if anywhere. In Fig. 2 is a view of a portion of several rows of blades belonging to the

upper half of the stator—that is, blades in the cover of the turbine. It is evident from the appearance of the blades in the photographs, that erosion of the blades, if such exists, is not sufficient to be apparent from these views. In order to illustrate this more fully, however, two vanes were deliberately broken out of the 8th and 12th rows, respectively, of the low pressure barrel for examination, and it was found that their metallic surfaces had retained their original polish and there was no trace of wear and no reduction in the cross section of the vane.

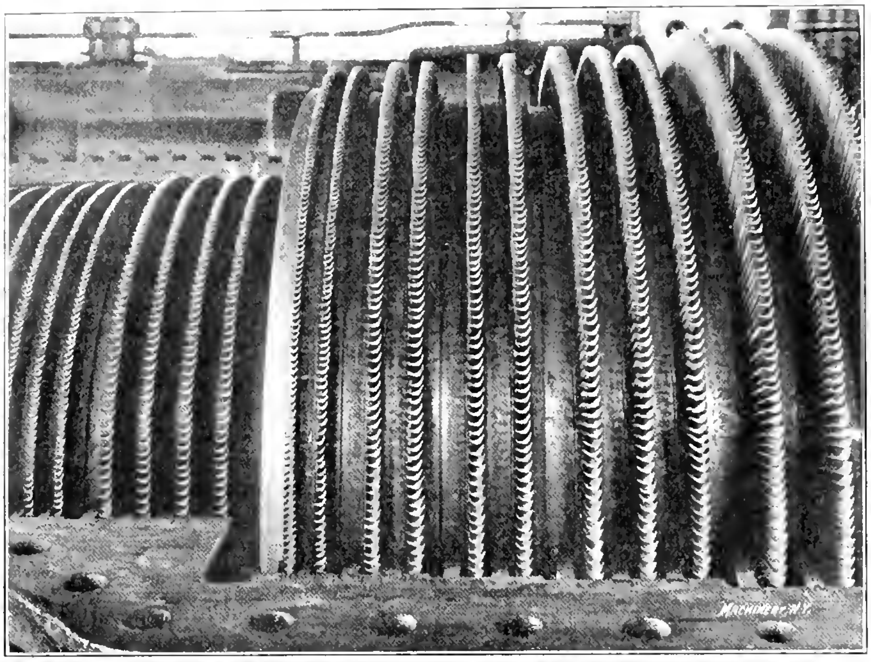


Fig. 1. Rotating Blades.

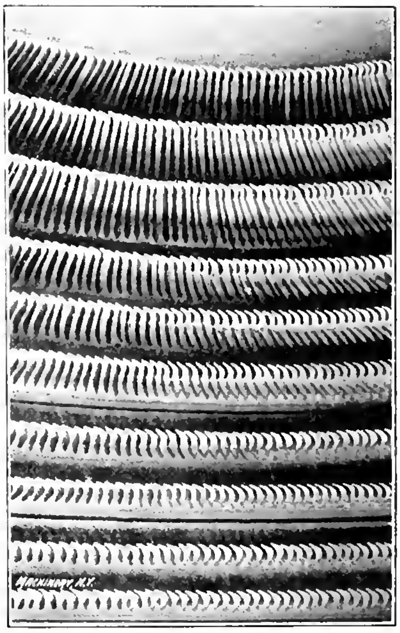


Fig. 2. Fixed Blades.

Photographs of the Blades of a Turbine after five years' Service.

The company informs us that the only effect traceable to steam wear on the vanes is to be found in the case of those which have been set slightly out of line with the remaining ones of their particular ring. In such cases the area projecting into the steam case becomes slightly scored upon the advance side. The effect has been the sharpening of the edges to such fineness, that a piece of heavy cord can be severed by them. In no case has the surface of the metal been worn away to an appreciable extent. One of the vanes broken out is shown in Fig. 3, where it is photographed so that it may be compared with a new vane and was selected because it showed the effect of wear as much as any vane that can be found in the turbine. The wear is scarcely perceptible in the illustration, but it occurs chiefly at the points marked *aa*.

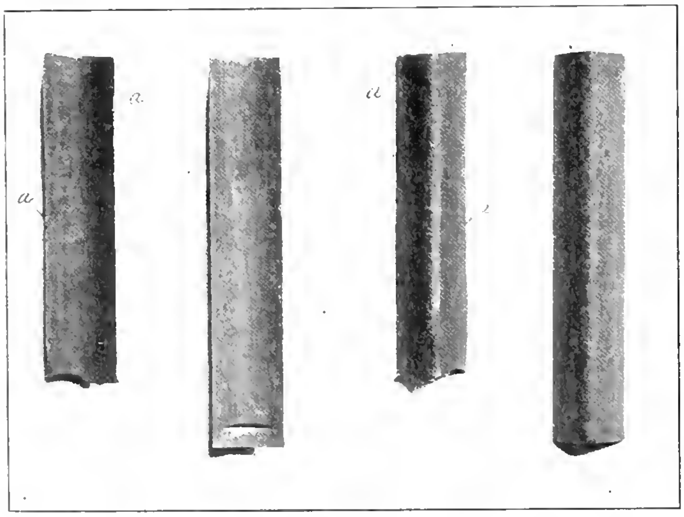


Fig. 3. Blades Broken from Low-pressure end of Turbine, compared with new Blades. These showed the most Wear of any Blades in the Turbine. Most of the Blades showed no Wear.

The foregoing facts are taken from an open letter issued by the Westinghouse Machine Co., sent to the press and called out in part by the publication of illustrations of vanes from Parsons turbines, both as made by their company and by firms abroad, in which apparently the blades are badly eroded, the inference being that the cutting was due to the action of steam. It is contended in this letter that where a badly worn vane is found, it must be due to something besides the action of the steam, since the velocity of steam in this turbine is so low as to produce no bad effect. In support of this claim illustrations in Fig. 4 are shown of a badly cut blade which is compared with a similar new blade. The damaged blade was taken from an experimental turbine in which several rows of blades were damaged by the accidental distortion of casing.

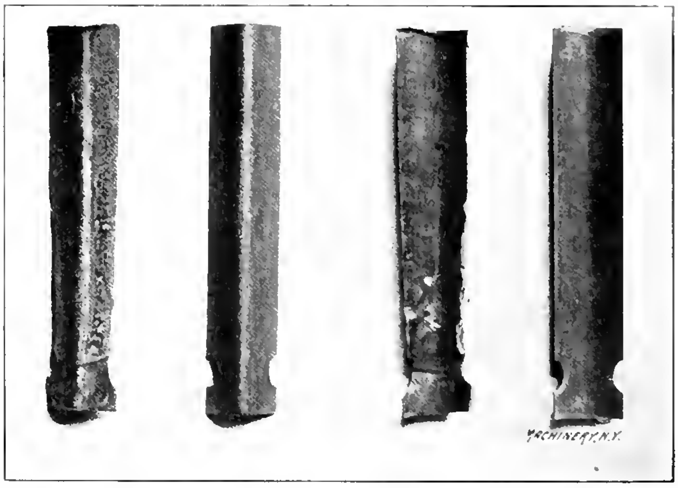


Fig. 4. New and Damaged Blades from an Experimental Turbine—Damage was not caused by Erosion, but by an accident to the Turbine.

The blade shown is not one of those damaged from this cause but its surface was worn away by flying particles of the damaged vanes in passing through the turbine. If unaccompanied by an explanation of the cause of this action, the illustration would lead to an erroneous impression.

* * *

The report of Chief Mason, of the Bureau of Ordnance states that black powder is now only used in the Navy for ignition, saluting purposes and for filling shells, its manufacture for other purposes having been entirely discontinued. Brown powder is no longer used, being replaced with a smokeless powder. Cordite, which was first used during the Spanish war, has proved unsatisfactory. It is uncertain in its action, and has great erosive effect on the bores of guns.

THE STEEL-HARDENING METALS.*

JOSEPH HYDE PRATT.

There are included under the head of steel-hardening metals, nickel and cobalt, chromium, tungsten, molybdenum, vanadium, titanium, and uranium, which are named in the order of the importance of their production and use for steel-hardening purposes.

The special steels resulting from these additions vary among themselves, having individual properties of tensile strength and elastic limit, of conductivity, heat and electricity, of magnetic capacity and of resistance to impact, whether as shell or as armor plate. It was only about twenty years ago that the first of these metals, nickel, began to be used to any extent for the purpose of hardening steel, but since their introduction their use for this purpose has continued to increase steadily. Experiments are still being carried on with some of these metals in order to determine their actual commercial value with regard to the qualities that they impart to steel. In the arts it is the ferro-alloy of these various metals that is first prepared and is then introduced in the required quantity into the manufactured steel, but this ferro-alloy is never added to the molten mass during the manufacture of the steel. All these metals give characteristic and distinct properties to steel, but in all cases the principal quality is the increase in the hardness and the toughness of the resulting steel. Some of the metals—as nickel, chromium and tungsten—are now entirely beyond the experimental stage and are well established in the commercial world as definite steel-hardening metals, and new uses are being constantly devised for the different steels, which are causing a constant increase in their production. Others, as molybdenum and vanadium, though they have been proved to give certain positive values to steel, have not been utilized to any large extent as yet in the manufacture of molybdenum or vanadium steel, partly on account of the high cost of the ores containing these metals. Titanium and uranium are still in the experimental stage; and, although a good deal has been written as to the value of titanium as an alloy with steel, there is at the present time very little if any of it used in the manufacture of a commercial steel.

Since the introduction of the electric furnace and the consequent methods that have been devised for reducing ores, it has become possible to obtain these ferro-alloys directly from the ores by reducing them in the electric furnace, and hence experiments have been conducted on a much larger scale than formerly.

Manganese Steel.

Besides the use of ferromanganese for the chemical effect which it produces in the manufacture of steel in eliminating injurious substances, it is also used in the production of a special steel which possesses to a considerable degree combined hardness and toughness. Such steel contains from 0.8 to 1¼ per cent of carbon and about 12 per cent of manganese and is known as "Hadfield manganese steel." If only 1.5 per cent of manganese is added, the steel is very brittle, and the further addition increases this brittleness until the quantity of manganese has reached 4 to 5.5 per cent, when the steel can be pulverized under the hammer. With a further increase, however, of the quantity of manganese, the steel becomes ductile and very hard, reaching its maximum degree of these qualities with 12 per cent of manganese. The ductility of the steel is brought out by sudden cooling, a process the opposite of that used for carbon steel. These properties of manganese steel make it especially adapted for use in the manufacture of rock-crushing machinery, safes, and mine car wheels.

Nickel Steel.

Nickel finds its largest use in the manufacture of special nickel and nickel-chromium steels, and the use of these steels for various purposes in the arts is constantly increasing. The greatest quantity of nickel steel is used in the manufacture of armor plate, either with or without the addition of chromium. There is probably no armor or protective deck-plate made which does not contain from 3 up to 5 per cent of nickel. Nickel steel is also used for the manufacture of ammunition hoists, communication tubes, and turrets on battleships, and for gun shields and armor.

The properties of nickel steel or nickel-chromium steel that make it especially adapted for these purposes are its hardness and great tensile strength, combined with great ductility and a very high limit of elasticity. One of the strongest points in favor of a nickel steel armor plate is that when it is perforated by a projectile it does not crack. The Krupp steel, which represents in composition about the universal armor-plate steel, contains, approximately, 3.5 per cent of nickel, 1.5 per cent of chromium, and 0.25 per cent of carbon.

Another use for nickel steel that is gradually increasing is the manufacture of nickel steel rails. During 1903 there were over 11,000 tons of these rails manufactured, which were used by the Pennsylvania, the Baltimore & Ohio, the New York Central, the Bessemer & Lake Erie, the Erie, and the Chesapeake & Ohio railroads. These orders for nickel steel rails resulted from the comparison of nickel steel and carbon-steel rails in their resistance to wear during the five months trial of the nickel steel rails that were used on the Horseshoe Curve of the Pennsylvania Railroad. The advantages that are claimed for the nickel steel rail are its increased resistance to abrasion and its higher elastic limit, which increases the value of the rail as a girder. On sharp curves it has been estimated that a nickel steel rail will outlast four ordinary rails.

Nickel steel has also been largely adopted for forgings in large engines, particularly marine engines, and it is understood that this is now the standard material for this purpose in the United States navy. There is a very great variety of these forgings and drop forgings, which include the axles and certain other parts of automobiles, shafting and crankshafts for government and merchant-marine engines and stationary engines, for locomotive forgings, the last including axles, connecting-rods, piston-rods, crank-pins, link-pins, and pedestal cap bolts, and for sea-water pumps.

Another important application that is being tried with nickel steel is in the manufacture of wire cables, and during the last year such cables have been made by the American Steel and Wire Co., but no comparison can as yet be made between them and the ordinary carbon-steel cables with respect to their wearing qualities.

In the manufacture of electrical apparatus nickel-steel is beginning to be used in considerable quantity. The properties of this steel which make it especially valuable for such uses are, first, its high tensile strength and elastic limit, and, second, its high permeability at high inductions. Thus steel containing from 3 to 4 per cent of nickel has a lower permeability at low inductions than a steel without the nickel, but at the higher inductions the permeability is higher. A notable instance of the use of this material is in the field rings of the 5,000 H. P. generators built by the Westinghouse Electric and Manufacturing Co. for the Niagara Falls Power Co. These field rings require very high tensile strength and elastic limit, and in order to reduce the quantity it is desirable that they have high permeability at high inductions. This result was secured by using a nickel steel containing approximately 3.75 per cent of nickel. Steel containing approximately 25 per cent of nickel is nonmagnetic and has a very low resistance temperature coefficient. This property is occasionally of value where a nonmagnetic material of very high tensile strength is required. The high electrical resistance of nickel steel of this quality, together with its low temperature coefficient, makes it valuable for electrical resistance work where a small change in the resistance due to change in temperature is desirable. The main objection to using nickel steel for this purpose is the mechanical defects that are often found in wire that is drawn for this quality of nickel steel.

For rock drills and other rock-working machinery nickel steel is used in the manufacture of the forgings which are subjected to repeated and violent shocks. The nickel content of the steel used in these forgings is approximately 3 per cent, with about 0.40 per cent of carbon. The rock drills or bits are made for the most part of ordinary crucible cast steel which has been hardened and tempered. There is a field for investigation here in respect to the value of some of the special

* From paper in "Mineral Resources of the United States," issued by the U. S. Geological Survey, 1904.

drills in the manufacture of rock-drill steels or bits. A nickel-chrome steel is now being made which is used to some extent in the manufacture of tools.

Nickel steel in the form of wire has been used quite extensively and for many purposes—for wet mines, torpedo defense netting, electric lamp wire, umbrella wire, corset wire, etc.—where a non-corrosive wire is especially desired. When a low coefficient of expansion is desired—as in the manufacture of armored glass, in the mounting of lenses, mirrors, lever tubes, balances for clocks, weighing machines, etc.—nickel steel gives good satisfaction. For special springs, both in the form of wire and flats, a high carbon nickel steel has been introduced to a considerable extent. Nickel steel is also being used in the manufacture of dies and shoes for stamp mills, for cutlery, table ware, harness mountings, etc.

Nickel steels containing from 25 to 30 per cent nickel are used abroad to some considerable extent for boiler and condenser tubes and are now being introduced into this country. The striking characteristic of these steels is their resistance to corrosion either by fresh, salt, or acid waters, by heat, and by superheated steam. The first commercial manufacture of high nickel steel tubes began in France in 1898, and was followed in Germany in 1899; but it was not until February, 1903, that these tubes were made in the United States. Since then, however, Mr. Albert Ladd Colby states:

"The difficulties of their manufacture have been so thoroughly overcome that the 30 per cent nickel steel, seamless, cold-drawn marine boiler tubes, now a commercial proposition, are made in practically the same number of operations, and with but a slightly greater percentage of discard than customary in the manufacture of ordinary seamless tubes, and, furthermore, the finished 30 per cent nickel steel tube will stand all the manipulating tests contained in the specifications of the Bureau of Steam Engineering, United States Navy Department, for the acceptance of the carbon-steel seamless cold-drawn marine boiler tubes now in use. In addition, the nickel-steel tubes have a much greater tensile strength."

Although the first cost of the nickel steel tubes for marine boilers is considerably in excess of the carbon-steel tubes, yet, on account of the longer life of the nickel-steel tubes, they are in the end cheaper than the others. At the present time 30 per cent nickel-steel tubes cost from 35 cents to 40 cents per pound, as compared with 12 cents to 15 cents per pound for the corresponding mild carbon-steel tubes. Thus their initial cost, when used in the boilers of torpedo-boat destroyers, is 2.13 times as great as the other kind and 2.43 times as great when used in the boilers of battleships, but the nickel steel tubes will last two-and-one-third times longer than those made of the carbon steel, and when finally taken from the boilers they can be sold not only for the market price of steel-tubing scrap, but also at an additional price of 20 cents per pound for their nickel content. Thus it is seen that 30 per cent nickel-steel boiler tubes are really more economical to purchase than carbon-steel boiler tubes.

In addition to marine boilers, high nickel-steel tubes can be used to advantage for stationary boilers, automatic boilers, and locomotive safe ends. It is the higher elastic limit of the 30 per cent nickel-steel boiler tubing that will prevent the leaks that are constantly being formed where the mild carbon-steel tube is used. The leaks are due to the expansion of the fluesheets when heated, which compress the tubes at the points where they pass through the fluesheets, and cause in the case of the mild carbon-steel tube a permanent deformation. This results in the leakage and necessitates the frequent expanding of the tubes. In the high nickel-steel tubes this difficulty is overcome by their higher elastic limit. This deformation and the resulting leakage are especially true of locomotive boilers. For automobile tubular boilers a 23 to 25 per cent nickel-steel tubing is used, each coiled section being made from one long piece of nickel-steel tubing, which, by a special heat treatment, is enabled to withstand this bending without cracking.

Nickel-steel tubing containing 12 per cent of nickel has been used by the French since 1898 in the manufacture of axles, brake beams, and carriage transoms for field artillery wagons, and the desired result in the reduction of weight has been obtained without loss of strength and without stiffness of the wagons. A 5 per cent nickel-steel tubing has been used in the manufacture of bicycles since 1896.

Chromium Steel.

The largest use of chromium is in the manufacture of a ferro-chromium alloy which is used in the manufacture of chrome steel. In the manufacture of armor plate ferro-chrome plays a very important part, and, although it is sometimes used alone for giving toughness and hardness to the armor plate, it is more commonly used in combination with nickel, making a nickel-chromium-steel armor plate. Other uses of chrome steel are in connection with five-ply welded chrome steel and iron plates for burglar-proof vaults, safes, etc., and for castings that are to be subjected to unusually severe service, such as battery shoes and dies, wearing plates for stone crushers, etc. A higher chromium steel which is free from manganese will resist oxidation and the corrosive action of steam, fire, water, etc., to a considerable extent, and these properties make it valuable in the manufacture of boiler tubes. Chromium steel is also used to some extent as a tool steel, but for high-speed tools it is being largely replaced by tungsten steel, which seems to be especially adapted to this purpose.

The percentage of chromium that is used in the chromium steels varies from 2.5 to about 5 per cent and the carbon from 0.8 to 2 per cent. The hardness, toughness and stiffness which are obtained in chromium steel are very essential qualities, and are what make this steel especially beneficial for the manufacture of armor-piercing projectiles as well as of armor plate. For projectiles chromium steel has thus far given better satisfaction than any of the other special steels, and is practically the only steel that is used for this purpose. The value of chromium steel for this purpose is well brought out by Mr. R. A. Hadfield, manager of the Hecla Works, Sheffield, England, who states that a 6-inch armor-piercing shot made by this firm was fired at a 9-inch compound plate, which it perforated unbroken. It was then fired again from the same gun and perforated a second plate of the same thickness, the shot still remaining unbroken

Tungsten Steel.

Tungsten steel is used to some extent more generally abroad than in the United States, in the manufacture of armor plate and armor-piercing projectiles. For this purpose it is used in combination either with nickel or chromium, or with both of these metals. The use for which tungsten steel seems to be best adapted is in the manufacture of high-speed tools and magnet steels. The property that tungsten imparts to the steel is that of hardening in the air after forging and without recourse to the usual methods of tempering, such as immersion in oil, water, or some special solution. For high-speed tools tungsten steel is especially adapted, as it retains its hardness and cutting edge even at the temperature developed in the use of these high-speed tools. The value of tungsten steel for permanent magnets is on account of it retaining comparatively strong magnetism and of the permanence of this magnetism in the steel. This property makes the tungsten steel particularly desirable in instrument work where the calibration of the instrument depends upon the permanence of the magnet used. For compass needles tungsten steel has been used by W. and L. E. Gurley with entire satisfaction.

Molybdenum.

The use of molybdenum steel continues to increase, and hence there is an increasing demand for the ores of this metal. The main use of ferromolybdenum is in the manufacture of tool steel. The properties which molybdenum gives to steel are very similar to those given by tungsten, the main difference being that it requires a smaller quantity of molybdenum than of tungsten to acquire the same results. Ferromolybdenum is produced, like ferrotungsten, by reducing it from the ore in an electric furnace. There are now two molybdenum-nickel alloys being produced, one of which contains 75 per cent molybdenum and 25 per cent nickel, and the other 50 per cent molybdenum and 50 per cent nickel. Besides these constituents the alloy contains from 2 to 2.5 per cent iron, 1 to 1.5 per cent carbon, and 0.25 to 0.50 per cent

silicon. The molybdenum steel which is made from these alloys is recommended for large cranks and propeller-shaft forgings, for large guns, rifle barrels, and for wiring and for boiler plates. The molybdenum increases the elongation of steel very considerably, and for wire drawing such an increase at a comparatively small cost is important.

Vanadium Steel.

On account of the extremely high price and scarcity of vanadium ores, the metal has thus far been employed very little in the manufacture of ferrovanadium for use in the production of vanadium steel. It is claimed by many that the beneficial properties imparted to steel by vanadium exceed those of any of the other steel hardening metals. These are exaggerated statements, but it may be found that smaller quantities of vanadium will give in some cases the same results that are obtained by comparatively large quantities of the other metals. One property claimed for vanadium steel is that it acquires its maximum of hardness not by sudden cooling, but by annealing at a temperature of from 1,300 to 1,170 degrees F. This property would be particularly advantageous for high-speed tool steel and for points of projectiles. There is, however, at the present time little or no vanadium steel on the market.

Titanium.

The actual commercial value of titanium as a steel-hardening metal has not been thoroughly demonstrated. Experiments have shown that from 0.5 to 3 per cent of titanium increases the transverse strength and the tensile strength of steel to a very remarkable degree. Until the development of the electric furnace it was practically impossible to produce either titanium or an alloy of iron and titanium, but since the introduction of this furnace ferrotitanium can be produced directly from the ores. It is to the manufacture of a special cast iron that ferrotitanium seems to be especially adapted. The titanium in the iron gives greater density to the metal, greatly increases its transverse strength, and gives a harder chill or wearing quality to a wheel made from such an iron. For the manufacture of car wheels it would seem that the titanium iron would be especially useful.

* * *

EXHAUSTING ARRANGEMENT FOR BUFFING WHEELS.

The exhausting arrangement for buffing wheels in the brass shop at Montreal of the Canadian Pacific Railway, here illus-

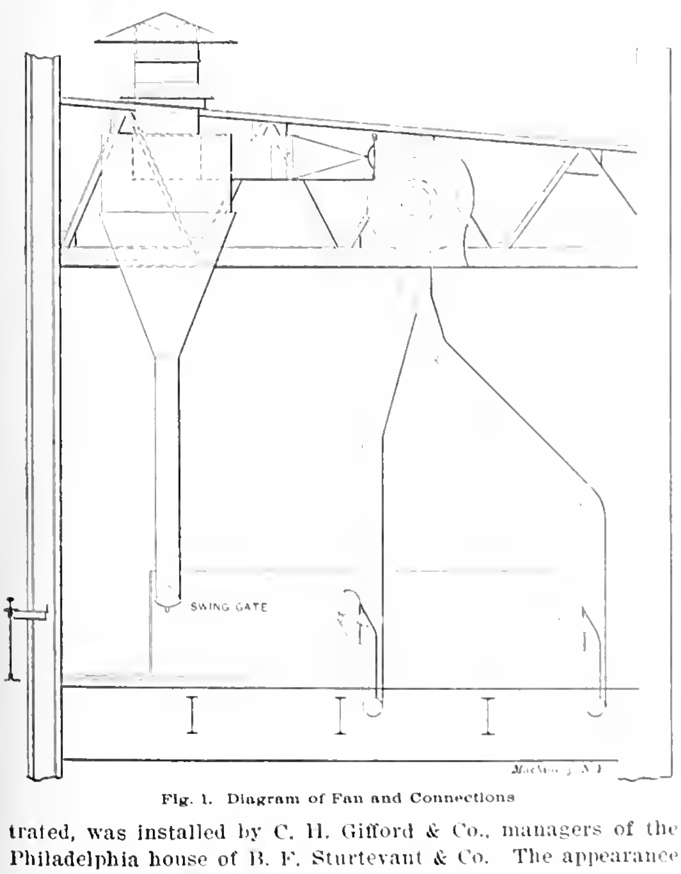


Fig. 1. Diagram of Fan and Connections

trated, was installed by C. H. Gifford & Co., managers of the Philadelphia house of B. F. Sturtevant & Co. The appearance of the shop with the exhausting arrangement in place is indicated by Fig. 2, and the arrangement of the apparatus by Fig. 1; the equipment consists of a 60-inch Sturtevant top horizontal steel plate exhauster designed to run at 720 revolutions per minute, and to discharge into a No. 18 Cyclone collector. Each hood is so designed that the heavy material

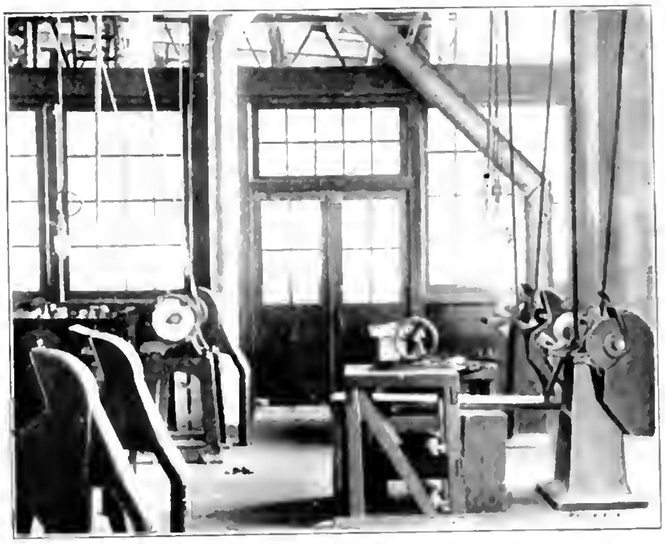


Fig. 2. View of Buffing Room

drops into the front extension, whence it may be removed, while the air and very light particles are carried into the exhaust system. The horizontal connections to the hoods are beneath the floor. The fan is supported on the roof trusses overhead, as shown in Fig. 1.

* * *

NOTES.

In the paragraph in the last number "Of Historical Interest," which related to an early machine shop in Philadelphia, we gave the name of its proprietor as Thomas Barritt. The name should have been printed Thomas Barnitt, and we make the correction in order to have our published record of this old machine shop correct.

The fifth annual session of the Summer School for Artisans, under the direction of the College of Engineering of the University of Wisconsin, begins June 26th and continues six weeks. Courses of study are in the following subjects: Engines and Boilers, Applied Electricity, Mechanical Drawing and Machine Design, Materials of Construction, Fuels and Lubricants, Shop Work. The entire laboratory and shop equipment of the college is used by the summer students.

The Atlas Engine Works, in common with many other progressive shops, have been conducting tests on various makes of high-speed steel. They find the speeds that they are able to obtain are limited quite as much by the nature of the work as anything else. Their engine shafts come rough turned, so they do not take off as heavy a cut after receiving them at the engine works as is the practice with forgings. On cast iron they believe it more economical to set a pace that can be obtained in nearly every instance, regardless of whether the castings are a little harder than usual, than it is to try variable speeds and leave the work too largely to the judgment of the workman. Work in a plant like this is largely of standard nature and parts are carried through in quantity. Cutting speeds of 50 to 55 feet per minute on band wheels and similar work are satisfactorily attained. Work that formerly took eighteen hours with ordinary tool steel and ordinary methods of day labor now take seven and one-half hours, using high speed steel. Cylinders that were formerly bored in three hours now can be completed in one hour with high grade steel, improved hoisting apparatus, and proper chucking facilities. They have had excellent results with Novo steel, and have also used Rex steel and Carpenter steel with great satisfaction. They find that Novo steel is readily worked into milling cutters, and on such work have run at speeds of 40 to 45 feet per minute

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Mr. James Hartness, of the Jones & Lamson Machine Co., Springfield, Vt., in the course of some recent remarks on the subject of the proper holding of work and tools, said that very few of the standard machine tools hold the work and tool with sufficient firmness of control to prevent lateral trembling or quivering. Under correct conditions the action of a heavy chip of steel on properly proportioned tools sometimes wears a slight hollow just back of the edge instead of wearing away the edge. This action, when it has been observed in the engine lathe, happens as a result of a balance of conditions, which includes an amount of clearance of the tool that just equals the feed, and which allows the tool to steady itself by riding on the finished surface. This prevents the quivering which would otherwise have rounded the edge before the chip could have had time to make an impression elsewhere. It is not enough to know that the tool mounting is capable of withstanding heaviest cutting strains without breakage, or even perceptible quiver. We must know that the controlling carriages are short, compact and unaffected by strains varying from light to heavy cuts. Tool holders and carriages are nothing more nor less than springs in equilibrium, and should be of the shortest, stiffest possible design. Chattering frequently occurs because there is no clip or cut large enough to hold all the slack of springing parts. The cure for chattering is frequently more, not less feed.

* * *

THE SLOTTER AS A MACHINE TOOL.

One of the peculiarities of the American machine shop practice is the neglect of the slotter; it is a machine rarely found in other but locomotive and marine engine works, although it is a tool admirably adapted to a large class of work commonly done on the planer and shaper. The design of the slotter is generally credited to James Nasmyth, the inventor of the steam hammer and an improver of machine tools generally; he is said to have developed it about 1836 from the wood mortising machine invented by Maudslay. Nasmyth also developed the shaper, and the slotter may be said to occupy an intermediate position between it and the planer, having the convenience and other good qualities of the former and all the accuracy of the latter. The slotter is a machine on which the work can be set up with the greatest ease, comparing in this respect with the boring mill. It is a machine unequaled for working to a line because of the facility with which the cutting tool can be followed with the eye; moreover, there is no accumulation of chips on the work to interfere with the vision. The work is rigidly presented to the cutting tool, the cutting stresses being directly transmitted through the table to the bed. Plane surfaces at any angle can be machined as readily as at right angles, and gears and other work, which have to be indexed, are handled with facility. The slotter is a tool that is practically indispensable in the railroad shop for handling driving boxes, cutting out valve yokes, slotting false valve seats and bushings, facing the ends of cast iron steam pipes, slotting of frames, etc.; and the features which make it so valuable on this work are of equal worth on many other features found in the average machine shop when the saving of time and accuracy of product are considered. Regarding the latter, it seems peculiar at first glance that the slotter should be found capable of producing accurate plane surfaces when it is so difficult to secure them with the shaper. Both machines have the cutting tool supported by a traveling head or ram, but with an important difference. The shaper has the cutting head mounted directly on the end of the ram, and the cutting stroke usually begins close up to the frame. The greater part of slotter work is done with a cutter-bar mounted in the toolpost of the ram, and projecting a considerable distance below it. In the shaper, the rigidity of support for the tool grows less and less as it travels out over the work, hence the tool is not uniformly supported. In the slotter the deflection of the cutter-bar is practically the same at the beginning of the stroke as at the finish, hence the deflection is uniform and a straight cut is taken throughout. On a great deal of slotting work it is necessary to use a slender tool or punchbar, but the same condition holds, for with the slender bar the deflection, while perhaps excessive, is uniform throughout the stroke.

* * *

Bill and Pete were two apprentices in Jackson's shop about equally matched in mischievous qualities, but with this important difference: When Bill played the time-honored trick on a green man of tying a bag of shavings to his lathe belt just beneath the countershaft cone, so that the moment the shifting lever was thrown over, the contents of the bag would be deposited over the lathe and operator, he did it in the clumsy fashion of getting a ladder and laboriously climbing up to the countershaft. When Pete played the trick he simply watched his chance when the man was absent from the machine and the foreman was looking the other way, tied the bag to the lathe belt, and then hauled it by hand up to the back side of the countershaft cone. It is needless to say that this difference in quickness of thought and grasp of a situation in the matter of playing tricks was equally as marked in after years in the more sober actions of life.

That the qualities, which differentiated Pete and Bill in youth, have a distinct money value is shown by the fact that Bill is now getting $2.25 a day as a journeyman, while Pete gets five times as much, and no lost time, as superintendent of a growing machine company in the West. Is this a reflection on Bill? Not exactly, for all men have their limitations and possibilities. Bill fills a niche and in a way is as indispensable as Pete, but there are more of him. One plans, the other executes; one works with his head, the other with his hands. Head work is useless without hand work, but fewer do it and the demand is greater than the supply. Hence those that supply it get better pay. In other words, it an illustration of the law of supply and demand. If this fact were more generally understood, it should prevent much of the jealousy and hard feeling that too often exists between workmen and their bosses.

* * *

The retirement of Mr. George A. Gray of Cincinnati, Ohio, from active interest in the business which bears his name marks the termination of a mechanical career that is a notable one, although little known outside of his immediate circle. Associated with Mr. Gray in the G. A. Gray Company, are Mr. A. Zuest, Secretary and Treasurer; Mr. H. Erdman, Superintendent, and Mr. Henry Marx, General Agent, who will continue the business on the same lines that have ensured its success in the past.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The John Fritz medal, which is given according to the rules for the award of the medal "for notable scientific or individual achievement," has just been presented to Lord Kelvin. Tho fund for the John Fritz medal was established in 1902, and the first medal was presented by the representatives of the four great engineering societies of the United States having tho matter in charge, to John Fritz himself.

After two years of poor markets and curtailed production, the steel industry seems to have come into great good times, the present consumption of steel being enormous. Several records for production were broken in March, one of them, a record of 42,387 gross tons of ingots produced by the open hearth furnace plant of the Clairton Steel Co. during the month, establishing a world's record for a 12-furnace plant.

Peat gas as a source of power is being seriously considered by many European engineers. A great difficulty in generating gas from peat is the formation of tar, which has to be separated; this tar carries away much of the heating power of the fuel. In a Deutz producer plant at Oldenburg, tests showed the fuel used, cut peat having 16.5 per cent of moisture, to be only 2.8 pounds per hour for each horse power. In a Koerting producer the peat used per horse power per hour was said to vary from 6.2 pounds, of a heat value of 2,250 British thermal units, to 1.65 pounds with 9,000 heat units per pound. Peat having an average value of 6,300 B. T. U. shows a fuel cost 50 per cent. greater when used in solid form to make steam, than when burned in a gas producer, and the resulting gas utilized in a gas engine.

An interesting paper was read by Mr. Otto Schlik before the Institution of Naval Architects, March, 1904, on the gyroscopic effect of flywheels on board ship, which was fully abstracted in the May, 1904, issue of this journal, Engineering Edition. A press dispatch from Berlin states that the Hamburg-American Line is building a new steamer at the Vulcan Works, Stettin, in which the invention of Mr. Schlik will be incorporated; it is expected that the rotating mass of a large flywheel, mounted in gimbal frames, will reduce the rolling of the vessel in a seaway to a minimum, and thus minimize the provocation to seasickness. It is also pointed out that if the invention proves successful that it will be of great value on battleships as it will greatly increase the stability of gun platforms. The invention has heretofore been tried on models only, and the new vessel will be the first practical demonstration of its utility.

The strength of timber treated with creosote or zinc chloride, as preservatives, was carefully studied by the Government Bureau of Forestry during the St. Louis Exposition. It was found that such reduction of strength as resulted from creosoting was due entirely to the steaming process required in the seasoning, and that it was in nearly direct proportion to the length of time that any steam pressure was applied. In the case of a green loblolly pine the diminution of strength was found to be 25 per cent after a pressure of 20 pounds was applied for ten hours. The treatment with zinc chloride does not seem to reduce the strength of the timber except for tho effect of the steaming process. The strength of a timber steamed four hours was the same with or without a treatment with an 8½ per cent solution with zinc chloride. The effect of the creosote seems to be the same in weakening the fiber as of an equal amount of water.

Perhaps one of the most difficult problems in engineering has been the working of the immense deposits of almost pure sulphur which underlie a large area of Calcasieu Parish, Louisiana. These deposits are overlaid with a thick stratum of quicksand which defied all ordinary methods of shaft sinking. After thousands of dollars had been sunk in what seemed like a hopeless enterprise the Standard Oil Company took hold of it and finally hit upon a way of getting the sulphur to the surface, which is as simple as it is ingenious. A number of 4-inch tubes were sunk into the sulphur deposit, and then steam was turned on from a large battery of boilers. The steam was admitted through one or more of the tubes and its heat was sufficient to soften the sulphur so that the pressure forced it out through the other pipes. From these it pours forth in a semi-liquid mass into tanks where it cools and hardens. When cooled it is broken up for shipment. The sulphur obtained from these wells is said to be nearly 98 per cent pure, and is worth $28 a ton at the wells.

Many street railway engineers, according to the *Street Railway Journal*, are of the opinion that something stronger than the chilled cast iron car wheel should be used on interurban lines operating at high speed. The danger of flanges breaking is greatly increased under these conditions, and the steel-tired wheel has been adopted on many roads as a solution of the difficulty. The Hartford Street Railway Company has been using such wheels under cars running under very severe service conditions for about four years, with remarkably good results. Some of these wheels have made mileages of between 100,000 and 200,000 miles each, covering over 200 miles a day, and are still efficient. Their tires have been turned several times, but will permit several more turnings. The Hartford Company has found that the cost of truing is minimized if the tire is turned up in the lathe after every 40,000 or 50,000 miles.

As to the cost, the average cost of a chilled cast iron wheel at Hartford is $6, which, for a service of only 30,000 miles, is 20 cents per thousand miles. Steel tires, as used at Hartford, cost $12, which, with three truings, after each 50,000 miles, and the original application of the tire, at a cost of $1 for each of these operations, makes the gross cost per 1,000 miles only 8 cents. The center of the steel-tired wheel does not require renewing, and should be considered part of the truck equipment.

In a letter to *Graphite*, Mr. John C. Kennedy, purchasing agent of the Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn., refers to an old pair of engines, still running with remarkable smoothness, which have an interesting history: "In 1844 Mr. Polk, of Tennessee, was elected President of the United States. The next Congress passed an act to build a navy yard in the interior of the country, where foreign vessels could not safely reach it. Memphis, Tenn., was selected as the site or place at which to build it. It was built and one double horizontal engine, 14 x 12-inch cylinders, both connected with the main shaft, making 58 strokes per minute, was put in to run the machinery. When the war between the States commenced, the Confederates took these engines to Nashville, and put them into a gun factory. After the fall of Donaldson the Federals took the engines from the works and set them up in the railroad shops, where they were used until 1865. They were then put up at auction by the United States government and were bought by the Nashville, Chattanooga and St. Louis Railway. When the new shops were built they were put in to drive all the machinery in the engine shop, and by rope transmission the boiler shop and blacksmith shop, and are running 23½ hours out of 24, 365 days in the year. Recently while the writer was showing some visitors through the works, he stood a nickel on edge on the bedplate, and it was standing there when they left the engine room."

Portland cement when mixed with water has two properties in regard to hardening which are known by separate names as "setting" and "hardening," the setting being the preliminary stage of hardening. Setting, according to the investigations of Le Chatelier, is due to the formation of a saturated solution of aluminum compounds. It takes place so rapidly

in many instances as to prevent the proper use of the cement. For the purpose of regulating the time of setting, gypsum, sulphate of lime, has been principally used. According to experiments made under the direction of Professor R. C. Carpenter, of Cornell, the retarding effect of gypsum on the setting is considerable, although there seems to be little or no advantage gained in adding more than 2 per cent of the sulphate.

The effect of adding gypsum is only temporary, provided the cement is exposed to the air, and for this reason other retarding materials have been sought for. Experiments made by Candlot would indicate that the addition of from 2 to 4 per cent of slaked lime to a cement containing a small percentage of gypsum which has through the influence of time lost its effect in retarding the setting, will restore the slow setting properties.

Chloride of calcium has been investigated as a retarding material, and it has been shown that with a feeble solution of this chemical the time of setting is greatly reduced, but when the cement is gaged with a concentrated solution of the chloride, it acts in just the opposite manner and tends to increase the rapidity of setting. Candlot, who has made some of these experiments, also states that a feeble solution of chloride of calcium acts very rapidly in slaking lime. A concentrated solution of chloride of calcium hardens Portland cement very rapidly, and causes its tensile strength to quickly reach the maximum, although at the end of a year no deteriorating effects seem to have been caused.

Chloride of calcium is a deliquescent material, which rapidly absorbs water, and it is possible that if ground dry with the cement clinker, if only to the amount of ½ per cent, which seems to be enough to cause the effect, it would cause the material to gather dampness and thus have a bad effect. Investigations are still necessary for determining whether the effect of chloride of calcium added to the cement before grinding is permanent or not.

COMPOSITION OF QUENCHING BATHS FOR TEMPERING CUTTING TOOLS.

The composition of a number of baths for quenching and tempering cutting tools is given by H. Le Chatelier, in an article in *Revue de Metallurgie*. Fused nitrates of potassium and of sodium are too high in temperature for certain cutting tools, as they do not permit of cooling below 220 degrees F. Mixtures of nitrate of potassium and of nitrate of sodium can, however, be employed, and a series of mixtures, fusing at different temperatures, be obtained. He gives the following proportions for these mixtures:

Temperature, Degrees F	Nitrate of Potassium.	Nitrate of Sodium.
280	0	100
230	20	80
172	40	60
137	55	45
145	60	40
225	80	20
335	100	0

Higher temperatures than 400 degrees F. cannot be obtained with these mixtures. At 400 degrees F. potassium nitrate freely decomposes, whereas in steels where without extreme hardness absolute absence of brittleness is necessary 500 degrees F. to 600 degrees F. are temperatures more suitable. The following bath gives, on fusion, a temperature of 500 degrees F.:

Sodium chloride	1 part
Potassium chloride	1 part
Fused calcium chloride	2 parts
Hydrated barium chloride	1 part
Hydrate strontium chloride	3 parts

For a bath fusing at 700 degrees F., the following mixture may be used:

Hydrated boric acid crystals	1 part
Silver sand	1½ parts
Anhydrous potassium carbonate	1 part
Anhydrous sodium carbonate	1 part

When prolonged treatment is required a little cyanide or charcoal may be added to prevent superficial decarburization; but in view of the strongly cementating action of cyanide, this salt must be used with caution.—*Mechanical Engineer.*

THE GUTERUTH VALVE FOR HIGH-SPEED PUMPS.

For some years past, says *Engineering*, high-speed pumps have been commonly fitted with mechanically-closed valves, and the necessity for this practice has been pretty generally accepted, although in certain cases it has been found that by fitting lighter valves the pump worked just as well after the removal of the closing gear as before. A description is then given of a novel form of spring-closing valve for high-speed pumps, known as the Guteruth valve, which is being introduced in Europe and meeting with success. It consists of a thin sheet of spring steel wound into a spiral spring as indicated in Fig. 1. The splined shaft upon which the spring is strung is also shown in the same cut. A section of a valve seat with the spring valve opened and the liquid flowing through, is shown in Fig. 2. By inclining the valve seat the valve does not obstruct the flow although it occupies an angular position of only about 30 degrees when open as against 90 degrees, which would be necessary if the seat were at right angles to the axis of flow.

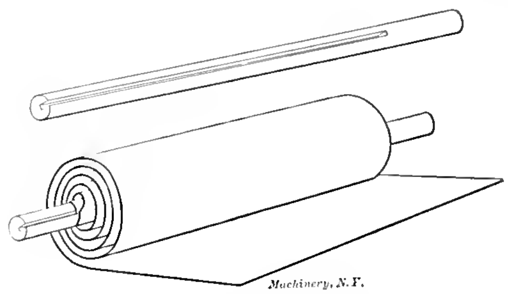


Fig. 1. Construction of Guteruth Valve.

The valve is very light in proportion to the area covered, hence its inertia neither greatly obstructs the flow in lifting from the seat nor causes it to slam when seating. Again its lightness makes it unnecessary to provide any guard to limit the lift. For low pressures the metal strip from which a valve is made is of uniform thickness throughout, but for high pressures it is necessary to thicken the end for the valve proper as indicated in Fig. 2. With properly proportioned apertures in the valve seats, however, a thickness of 1/16 inch has been found ample for the highest pressures met in common service.

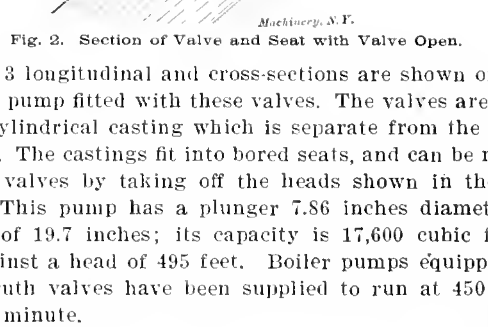


Fig. 2. Section of Valve and Seat with Valve Open.

In Fig. 3 longitudinal and cross-sections are shown of a double-acting pump fitted with these valves. The valves are mounted on a cylindrical casting which is separate from the body of the pump. The castings fit into bored seats, and can be removed with the valves by taking off the heads shown in the cross-section. This pump has a plunger 7.86 inches diameter, and a stroke of 19.7 inches; its capacity is 17,600 cubic feet per hour, against a head of 495 feet. Boiler pumps equipped with the Guteruth valves have been supplied to run at 450 revolutions per minute.

NOTES ON SOLDERING COPPER CONDUCTORS.

Electric Club Journal, January, 1905.

Cleanliness and heat are essentials for a good soldered joint, and must be kept in mind in every job. In making an ordinary spliced joint, the wires are each bared of insulation for a distance of about one inch from the joint and carefully cleaned by the use of sand paper or emery cloth. The emery cloth is preferable because it is so tough and flexible that a rapid scouring of the surface can be made.

The two ends of the cleaned wire are butted together after

slipping over them a carefully cleaned sleeve. The surfaces may be brushed with a solution of sal-ammoniac, or what is preferable, coated with a soldering paste. A solution of resin in alcohol is sometimes employed for this purpose. The joint is now ready for the application of the solder. It is heated by a hot soldering iron or in the flame of a hand-torch until the application of a soldering stick to its surface shows that the solder will readily flow over the cleaned surfaces. Certain precautions must be observed in heating the joint, as, for instance, not to get the surface too hot, as the copper will then oxidize. Neither must the surface be too cold, as the solder will not then readily flow, as a consequence of which the joint may be imperfectly united, or because of frozen drippings, it will present stalactitic points which have to be cut or filed off before tapping the joint. It is absolutely necessary that the soldered joint have a smooth surface, otherwise the insulation will be cut.

If, however, the joint need not have mechanical strength and is only required to be electrically conducting the use of a sleeve may be dispensed with. The wires may then be placed side by side overlapping and wrapped with fine copper wire, about No. 26 in size. The fine wire holds the joint in position. Care should be used in wrapping that the wrapped wire presents no sharp points. Solder is now flowed on as before. After a sufficient amount has been put on to cover the surface, and the interstices of the fine wire are filled, it is advisable to wipe the joint with a cloth just as a plumber does in wiping a joint. This removes any excess of solder and makes the joint smooth on its surface.

If the conductor is two wires in multiple and it is desired to solder it to a similar pair of wires, it is usual to cut one wire of each pair half an inch to an inch shorter than the other and then place the two conductors together. These may be wrapped as above and their soldering presents no difficulty. Obviously, this may be extended to the soldering of any number of conductors in parallel.

It is sometimes necessary to solder a sheet copper strip to a wire in order to provide a flexible lead for wires of large size. After the surfaces are cleaned one end of the copper strip is formed to fit the wire to which it is to be soldered. After fluxing, the soldering operation is performed as usual. If a single copper strip does not provide sufficient conductivity for a wire cable, two or more of them are placed in parallel upon it, in which case difficulty is apt to be experienced from the flowing of solder between the strips.

Solder will always run on hot copper. To obviate this difficulty it is usual to place strips of material between the sheets of copper to prevent their being united by the flowing solder.

Copper wire up to the size of No. 0 may readily be soldered by a soldering iron of the usual size, say an inch and a quarter square. With larger sizes a torch must be used unless one has a pot of hot solder with a couple of ladles, when the hot solder may be poured from the ladle directly on the joint. This can be accomplished by pouring upon the joint and catching the drip in the ladle underneath the joint. If the joint is of such a size that it is not warmed at the first pouring, the lower ladle may be brought over the joint and a second pouring may be made. This process is to be continued until the joint is thoroughly hot, which will be apparent from the fluidity of the molten solder running through it. If a sufficient amount of solder is not retained in the joint, as may happen if the joint is too hot, it may be filled in from a small stick of solder and then wiped as it cools to secure the requisite smoothness.

In soldering one cable to another cable it is usual to interleave the fine wires to a sufficient length and then wrap the whole with fine wire, after which it may be treated in the usual way. When a cable is to be inserted in a sleeve or a terminal plug it may be dipped in the soldering fluid and then plunged into molten solder. The plug in which the cable may be placed can be tinned in the same manner. The receptacle of the plug is now filled about half full of solder, when the tinned cable may be plunged into it. The parts should be solidly in position and remain undisturbed until cooling has taken place.

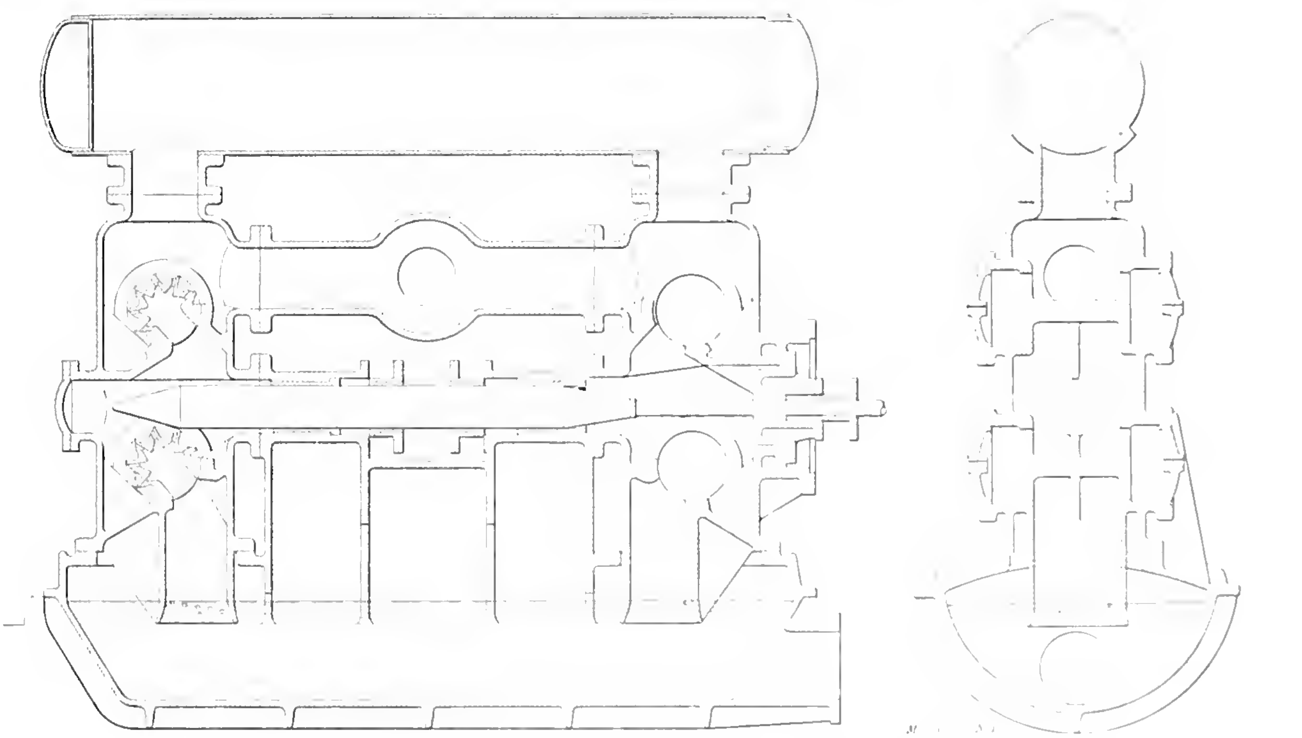


Fig. 3. Longitudinal and Cross Sections of Double-acting Pump Fitted with Outeruth Valves

WATER TUBE BOILERS FOR GERMAN CRUISERS

Der praktische Maschinen Konstrukteur, December 8, 1904

The water-tube boiler after many years of trial seems to have finally established itself permanently in the naval marine. Just what final form it will assume is, as yet, uncertain.

Among the latest vessels to be fitted with this type of boiler are the German cruisers of the classes known as C and D. The form used is shown in the illustration on the next page. In the outer nest of tubes *I*, those of the cluster I are bent out so as to form a chamber. The gases of combustion first pass through the central nest *III* as usual, and then curving through an S-shaped path traverse the outer nest, *I*, in such a way as to again mingle with the air. Should it so happen that the fire is not burning evenly over the whole surface of the grates, the hot gases will be thoroughly mixed together in this chamber. The two nests of tubes are not brought close together in this case, but there is a narrow space *h* left between them, which serves as a means of kindling the unburned gases. In addition to this, fresh air is admitted through the front and back walls of the boiler into the combustion and fire chambers.

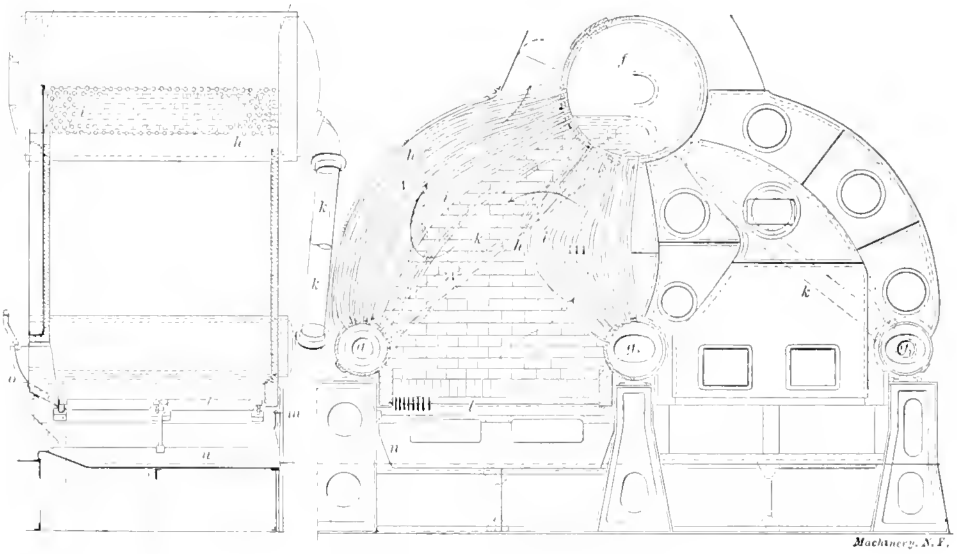
As a consequence of this rational method of conducting the

combustion the production of smoke is reduced to a minimum, a matter of great importance in naval work. Great clouds of smoke emitted from the stack are a great hindrance to the gunners on board, besides serving to make the ship visible to tho enemy at great distances.

The combustion chamber also serves as a reservoir of heat, where the varying temperatures of the gases are equalized. The result is that the stresses imposed in service in this boiler are not as severe as in the ordinary water-tube boiler.

A further improvement in this boiler as compared with the standard type is to be found in the three bottom shells g, g_2 and g_1, the two outer of which are connected to the main shell by large tubes that are beyond the reach and influence of the fire gases. Here there are two tubes k and k_1 connecting g and g_1 respectively with the main shell f, while g_2 is connected direct by the central nest III.

In some of the later boilers this outside connection is done away with, as it has been found that the circulation is satisfactory and efficient without it. Observations have also shown that the best results are obtained when coal is burned on the grates of these boilers at the rate of about 50 pounds per square foot per hour. G. L. F.



German Water Tube Marine Boiler.

PRACTICAL INVESTIGATIONS IN THE GAS TURBINE PROBLEM.

Dr. Chas. E. Lucke, in the Engineering Magazine, April, 1905.

The receiving of a jet of fluid and bringing it to rest is the function of the rotating part of every turbine, and work is done by this member only because it can bring to rest the jet of fluid once formed with a given velocity. The velocity is given to any fluid or gas by forcing it to flow through an orifice or nozzle from a place of high pressure to one of low pressure. For an incompressible fluid such as water there is no change in density and hence no expansion of the mass with the change of pressure. If the fluid be a perfect gas, however, it will change density with the pressure change, and suffer an expansion in addition to the phenomena present in constant density fluids. Such expansion through a nozzle is termed "free expansion." In perfect gases, then, in addition to the velocity due to pressure drop with density constant, as in the case of liquids, there is also a velocity due to change of density as the result of pressure and temperature change. In the case of a vapor such as steam, free expansion adds an additional phenomenon, that of partial condensation or possible superheat. In the case of a vapor, therefore, there are in addition to the first two velocities named a third increment of velocity due to this change of state. These phenomena may be divided into purely mechanical action and thermal action. As the kinetic energy of the resulting jet is due to all three velocity increments for a unit mass flowing, that part of the resultant kinetic energy that is due to free expansion of a perfect gas or vapor is also dependent on the thermal characteristics of the fluid. This part of the kinetic energy of the jet is measured by the amount of heat that has been given up by the fluid to give the mass the velocity increment due to free expansion.

The turbine engine using expanding fluids such as steam or a perfect gas depends for its possibilities of output and efficiency on first, a mechanical action in the jet, and second, a thermal action, of which the latter may be absent. The turbine may be useless if the maximum amount of original energy of the fluid is not first converted into kinetic energy of the jet. The mechanism so far used for conversion of the original potential energy of the fluid into kinetic energy of the jet is the nozzle; practically all nozzles in use were designed on some assumption of the phenomena taking place in free expansion, because there is not in existence sufficient experimentally verified information to permit of a more positive method.

The classification of gas turbines is particularly applied to those turbines using the products of combustion from a fuel and air previously compressed. There are three elements to the system of any of these: a, a compression pump for air and fuel; b, a receiver for the fuel and air compressed and a pressure combustion chamber to convert the fuel and air into hot gas; c, the turbine proper to use the hot gases. The efficiency of the system will depend primarily on the efficiency of conversion of the heat of the hot gases from the fire to kinetic energy of these gases after the expansion. For this conversion to be good, the temperature of the hot gases must be lowered in acquiring velocity. Expansion in a cylinder behind a piston is termed "balanced" expansion, because the pressure of the gas is always balanced by the piston resistance and the mass is practically at rest. It is well known that such balanced resistance will cool the gases, and by this cooling heat is converted into work. It has been taken for granted by many that by a free expansion in a nozzle, the temperature drop would be the same as for expansion behind a piston; experiments to determine how to produce equivalent results by free and balanced expansion have, however, been far less numerous than the reiteration of statements that such equivalence must exist.

A few experimental facts may be shown to bear upon this case. One style of ice machine compresses air, cools it after compression to the temperature of whatever water is available, and subsequently expands the air in cylinders, the exhaust from the cylinders for even moderate initial pressures being cold enough to freeze water. The cooling resulting from this balanced expansion gives results which agree very well with those theoretically computed on an assumed law. Inventors have, however, sought to substitute for the second or expanding cylinder in the above process, free expansion in a simple nozzle, assuming equivalence of results of free and balanced expansion. This attempt has met with total failure, the air after passing the nozzle being only a few degrees cooler than before passing. This may be explained in part by the fact that the air in the system loses velocity by

impact, and so suffers a temperature rise, but this does not account for the whole difference observed, because water cannot be made to freeze on the nozzle itself, with air that easily freezes water on the exhaust pipe of the air cylinder operating under balanced expansion.

A thermometer held in the stream of air issuing from an open valve or nozzle on a compressed air main will show for even a pressure drop of 100 pounds per square inch only 3 or 4 degrees temperature change. To eliminate possible errors due to impact of the air on the thermometer, the author measured the temperature of the air when moving at the maximum velocity by means of a thermal couple made of fine wire, stretched axially along the jet. These tests show a maximum temperature drop of only 30 degrees Fahr. for air expanding through a steam turbine nozzle from 100 pound pressure down to the atmosphere. This result is only 12 per cent. of the temperature drop that would have resulted in balanced expansion without gain or loss of heat.

The experiments of Tripler and Linde in liquefying air likewise show a lack of equivalence between balanced and free expansion. Air compressed to 2,000 or 3,000 pounds per square inch was cooled by water, and then some of the air freely expanded through a hole, the discharge passing around the pipe feeding the hole. This was intended to cool the air in the pipe below its critical temperature for liquefication under the high pressure used, but the results were very different from the case of balanced expansion. The temperature drop through the nozzle being only about ¼ degree F. per atmosphere-pressure drop, according to one report. The results for the Linde process are here shown, the initial pressure being 220 atmospheres.

Temperature approaching the Nozzle.	Actual Temperature Drop through Nozzle.
+ 30 deg. F.	35 deg. F.
0 deg. F.	65 deg. F.
— 30 deg. F.	80 deg. F.
— 60 deg. F.	96 deg. F.
—100 deg. F.	112 deg. F.
—150 deg. F.	135 deg. F.

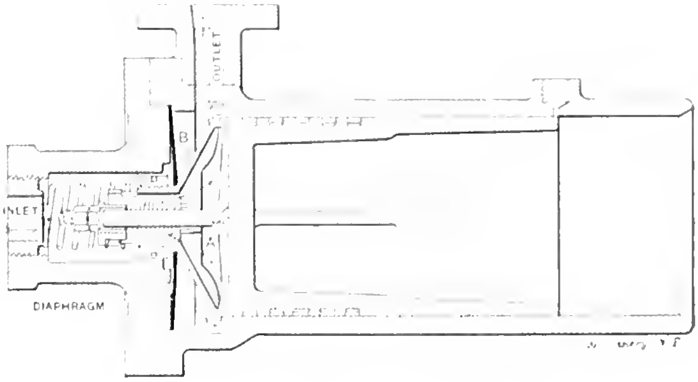
Unless, by an increase of knowledge of free expansion of perfect gases, it becomes possible to produce results equivalent to those obtained with balanced expansion, there cannot be the same amount of heat transformed into work by the gas turbine engine as by the cylinder-and-piston gas engine.

In conclusion, the situation may be summed up by saying that so far no work has been done that warrants any assumption of equivalence, and the difference is so great that the pure gas turbine, provided with the simple nozzles used by steam turbines, is a failure commercially, and can never rise above this until some method has been found to make results by free expansion more nearly equal to those obtained in cylinders.

AIR COMPRESSOR WITH MINIMUM CLEARANCE SPACE.

The two features which most largely affect the economy of air compressors are the means for cooling the air as it compresses, and the amount of clearance space between the piston and cylinder heads. In a recent issue, *Engineering* describes the Kryszat air compressor, built in Great Britain by Shaffer & Budenberg, Manchester, in which the clearance space is reduced to practically zero. Therefore the volumetric efficiency is in effect very nearly 100 per cent, *i. e.*, the volume of free air compressed in a given time should equal the cubic contents of the cylinders, multiplied by the number of working strokes. In the ordinary type of air compressor having more or less clearance space, the compressed air in this space expands as the piston retreats on the induction stroke, and thus reduces the volume of free air which can be drawn in. When the compression is high, the reduction in volume of free air drawn in becomes very serious; with very high compression it may become such a percentage of the stroke that the compressor is totally inefficient. Hence the necessity for very small clearances—the smaller the better.

The Kryszat air compressor is single-acting and built very much on the lines of a small gas engine. Air is drawn in through the center of the cylinder cover, and discharged through the vertical branch near the back end of the cylinder. The arrangement of the valves is seen in the figure, a vertical section through the cylinder and cover. In this illustration *A* represents the suction valve and *B* the delivery valve. The latter is carried by a circular diaphragm of sheet metal held in the counterbore of the cylinder by the cover. The seating of the delivery valve is formed on the inner end of the cylinder barrel, and the valve is held to its seat by the larger helical spring shown, the pressure of which can be adjusted by the screwed collar in the suction orifice. The suction valve is in the form of a flat disk, the seat of which is on the face of the delivery valve, to which it is held by the smaller helical spring.



Air Compressor with Minimum Clearance Space

When the piston starts on its forward stroke, the suction valve is lifted, and free air enters the cover and passes into the cylinder through the center of the delivery valve. When, on the return stroke, the air is sufficiently compressed, the two valves move back together, and the air escapes into the annular space surrounding the discharge valve and emerges by the vertical outlet. Owing to the large diameter of the valves, a very slight lift is necessary to give free passage to the air when entering and leaving the cylinder, and it will be seen that the clearance may be reduced until the piston actually comes in contact with the surface of the suction valve without danger. Owing to the small lift of the valves and the short stroke of the piston they can be run at about 30 revolutions per minute.

EXPERIMENTS WITH CUTTING TOOLS AND APPLICATION TO LATHE DESIGN.

Institution of Mechanical Engineers, February 13, 1905

Professor J. T. Nicolson, of the Municipal Technical School of Manchester, England, is well known for the tests on the performances of cutting tools which he has made during the last year or so, his "Experiments with a Lathe Tool Dynamometer" having been widely reported in the technical press. In a lecture on the "Results of Force Measurements with Cutting Tools and the Application to Lathe Design," delivered before the Institution of Mechanical Engineers, February 13th, and based largely on these experiments, he suggested that the lathe bed as usually made is badly designed. According to Professor Nicolson the lathe bed has been designed mainly with a view to withstand forces tending to bend it, whereas torsional forces are possibly in some cases of greater importance than bending. Experiments carried out by Professor Nicolson have resulted in much data on the side, vertical and end pressures on cutting tools. As stated by our English contemporary, "Engineering," such data are hardly necessary in the case of machine tools worked with the old carbon steel tools, because experience has already led to quite satisfactory proportions for all such tools. Where, however, machines are to be operated with the high speed steels, Professor Nicolson's Manchester experiments should aid in bridging over that period in their manufacture in which the designs are to a large degree tentative. Some points brought out in the lecture, as abstracted from *Engineering*, are as follows:

Professor Nicolson's experiments have shown that with a cutting angle of 80 degrees for cast iron (tool angle 75 degrees) and of 70 degrees for soft steel, the horse power needed at the point of the tool is about 2 horse power per pound of chips per minute. To this must, of course, be added the power needed to drive the tool light, which, in the case of light cuts, is a large proportion of the whole, and is the main

reason why a heavy cut and a slow speed are more economical of power than a light cut at a higher one. Where the chips come off in the same shape and fashion, and the tools are equally sharp, the net horse power expended in the actual cutting operation is practically the same per pound of metal removed whether a light or a heavy cut is taken. The power to be provided will, of course, depend upon the heaviest cut which the tool is to take. This will generally be heavier in a turret lathe than in a common lathe operating on work of the same diameter.

For the common lathe Professor Nicolson finds that practice seems to agree well with the rule that the heaviest cut is 1-40th of the height of the centers in depth, and the traverse is 1-160th of the same height. The area cut is then $\frac{h^2}{6400}$, where h is the height of the centers. The speed of cutting may be

$$v = \frac{1}{a} + 15 \text{ for soft steel,}$$

and

$$v = \frac{1}{4a} + 20 \text{ for cast iron.}$$

Here v is the cutting speed in feet per minute and a is the area of cut in sqnare inches.

The force needed to produce a chip of given area is not, it should be mentioned, a function of this area only, but is dependent upon three factors in addition, which Professor Nicolson calls the bluntness effect, the angle effect, and the "crowding" effect. The tool in practice is never ideally sharp, but is curved at the point to a radius which, if small, is always finite. The block of metal just over this rounded point is carried up with the tool bodily, and is thus subject to a shearing strain, failure taking place when the angle through which it is strained reaches a limit which differs with different materials. The work thus done varies proportionately to the square of the radius of the cutting edge. In very tough materials, such as copper, the shear angle at which failure occurs is very large, hence for satisfactory work the radius of the cutting edge must be small, or, in other words, keener tools should be used on a material like copper than on steel, and keener on steel than on cast iron.

A difference in the cutting angle of the tool also has a marked effect upon the power required to remove a given weight of chips. It does not, however, pay to adopt for the tools that angle at which the cutting force required is least, since the tool lasts better with a much larger cutting angle. The best cutting angles in practice appear to be 70 degrees for steel and 80 degrees for cast iron. These angles are the angles between the upper surface of the tool and the tangent to the work cut, so that the actual tool angles are about 5 degrees less. A peculiar feature which has been noted with high-speed steel is the fact that the wear is not at the point of the tool, but at some distance back from it. Indeed, it appears that the force on the tool is not greatest at the point where the metal is separated, but at some distance further back, where the shaving is curled up. The consequence is that the very hot shaving obtained in using high-speed steel is pressed on to the tool with maximum force some distance back from the point, and as it is moving rapidly, the combination of the high temperature and friction wears a groove in the tool, the latter failing as soon as this groove reaches the cutting edge. With small tool angles this soon occurs, but with greater angles much more metal must be eroded before the cutting edge is reached by the groove. The "crowding" effect arises from the fact that the chips, in coming off, swell both in width and thickness. Hence, if a tool is cutting in anything but a single plane, as is necessarily the case with a round-nosed tool, the portion of the resultant chip coming off at one point interferes with the motion of that coming off at other points, with the result that the parts are crowded into each other, so that more power is needed to remove a given weight of metal than would otherwise be required. An extreme case is that of a parting-tool, where, as is well known, much lighter cuts must be taken than in surfacing work.

Another point touched on by Professor Nicolson was the proper proportioning of the step-pulley and change gears. Unless special arrangements are made, only a finite number of speed changes can be provided for. The highest speed should be that enabling the tool to give its maximum possible output on the smallest diameter which it is profitable to turn in the lathe, and this, according to Professor Nicolson, may be a diameter of one-eighth the height of centers. The lowest speed should be such that the maximum output is also attained on the maximum diameter which can be swung on the lathe. The number of intermediate changes of speed which should be provided for is mainly a commercial question. From a consideration of the cost of each additional change of speed, and the loss arising from the impossibility of running the lathe at the speed most appropriate to every diameter, Professor Nicolson considers that the geometric ratio between successive speeds should be 1.08 in the case of a 6-inch lathe and 1.24 in the case of a 72-inch lathe. That is to say, if R be the maximum of revolutions per minute provided for and r the smallest, then, in the case of a 6-inch lathe, $R = r\ (1.08)^n$ inches, where $n + 1$ is the total number of speed changes.

MACHINISTS' PROTRACTOR.

Zeitschrift fur Werkzeugmaschinen und Werkzeuge, December 25, 1904, page 123.

The small instrument shown in the accompanying engraving is a useful one for the machinist. It can be used not only as a level but a means of measuring an angular variation from the vertical and horizontal. It can be folded so as to go in the pocket. Two applications are shown in Figs. 1 and 2.

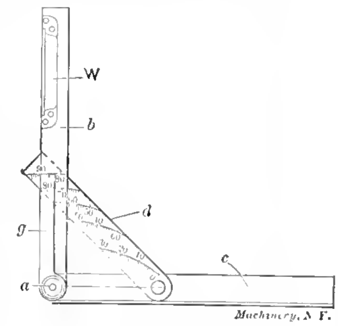


Fig. 1. Protractor Measuring a Right Angle.

As will be seen from the illustrations, the instrument consists of two bars b and c connected by a pivotal joint. To the bar c there is also pivoted a shorter bar d. Upon the latter a number of arcs are drawn with the same radius from the pivotal point a, the length of this radius being $a\,f$, as indicated on arm b in Fig. 2. Further, a shorter arm g, of length equal to the radius, is pivoted at a to b. This serves to measure any angle greater than 90 degrees, as shown in Fig. 2.

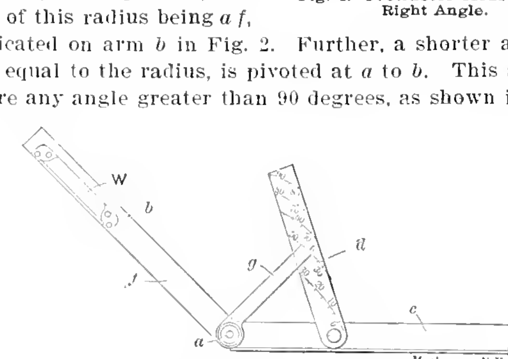


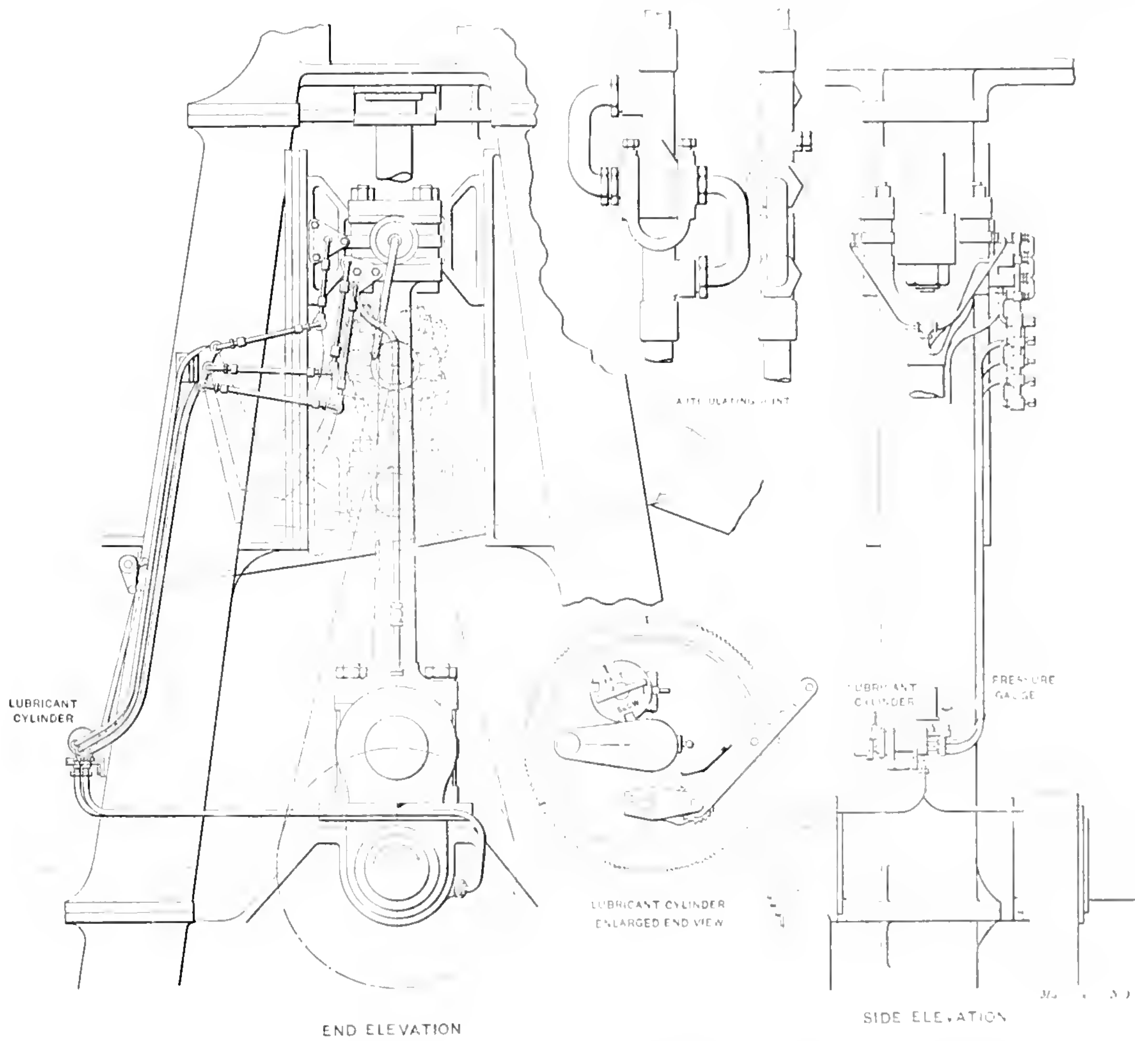
Fig. 2. Protractor Measuring an Obtuse Angle.

There is also a spirit level on the arm b at W in order that any variations from a horizontal may be measured. Angles are measured by opening the instrument and noting the graduation coinciding with the point f. For angles greater than 90 deg., the readings are taken from the arm g.

FORCED GREASE LUBRICATION SYSTEM.

In the December, 1904, issue of the *Indian and Eastern Engineer*, a forced grease lubrication system for marine engines was illustrated, which is of considerable interest at the present in view of the improvements being made in machinery lubrication generally. As will be seen from the illustration, the grease is forced by a piston and cylinder through a system of distributing pipes to the various bearings, including not only those which are fixed like the crankshaft, but those having a reciprocating and revolving motion like the crosshead and crank-pin. These pipes are fitted with a system of articulating joints, which permits them to follow the motion of the crosshead, etc., and carry the grease to them under some pressure. The piston of the grease cylinder is operated by a ratchet arm connected to some part of the valve motion from which it gets an oscillating motion. The

manufacturers of this system of grease lubrication, Thompson Bros., 155 Fenchurch Street, London, E. C., claim a very material saving in the cost of lubrication of marine engines by this system as compared with the use of oil or grease applied by oilers in the usual manner. It has been applied to vessels aggregating 100,000 horse power, principally in service to the Orient. Figures published for one vessel, tonnage not given, which with oil lubrication had required 681 gallons of oil for a round trip of four months, at a cost of approximately $250 for oil alone, show that with the forced grease lubrication, the expense for oil and grease (oil still being used on some of the bearings) was reduced to $200 and the number of oilers reduced from six to three, whose wages for the round trip amounted to $390, making the total saving about $140.



Forced Grease Lubrication System for Marine Engines

STEAM ENGINE RESEARCH.

First Report of the Committee of the Institution of Mechanical Engineers, March 17, 1905.

At the meeting of the Institution of Mechanical Engineers, March 17, the first report of the Steam Engine Research Committee was presented to the Institution by Professor Capper. This report, in which are incorporated the results of over 100 tests extending over six years on jacketed and unjacketed cylinders, was particularly directed to the determination of leakage through the slide valve and piston into the exhaust, and also to research upon the subjects of condensation and re-evaporation upon the cylinder walls.

The engine used in the experiments was a horizontal compound, having cylinders of 6½ inches and 11¼ inches diameter, by 14 inches stroke, arranged side by side, the cranks being placed at right angles. Each cylinder was separately jacketed on the barrel and ends, the supply and drain on the ends being separate from that on the barrel. Each cylinder was fitted with a Meyer expansion valve, adjustable by hand, so that the cut-off could be varied for each cylinder between ¼ and ⅝ of the stroke. Either cylinder could be arranged as a simple engine by a grid valve on admission and exhaust sides and the engine could be made single acting by b... either of the Meyer plates. A first series of trials was ma... with the engine arranged as a single cylinder, high pressure non-condensing jacketed engine; the second series being the same, except that it was made without jackets. Before beginning the tests it was determined that the variables should be temperature and speed, cut off and other conditions being kept constant.

It is evident that any steam leaking through the slide valve or piston of a steam engine to the exhaust will not be shown on the expansion curve of the indicator diagram, and that any other leakage through either piston or valve will affect the diagram so as to modify the conclusions drawn without taking such leakage into account. Messrs. Callendar and Nicolson have shown that such leakage may be considerable. The analysis made in the present experiments confirms the conclusions at which they arrived, that without making allowance for this leakage no correct determination can be made of the relative weight of steam and moisture present in the cylinder. In this connection it was found that the leakage under given conditions was less when the cylinder barrel was warmed by the jacket than when the barrel was cold.

In making the leakage tests to be described, the high pressure cylinder with the ordinary valve was used, the steam ports being blocked. Steam was admitted to the steam chest, and the engine being driven by external power, the steam escaping into the exhaust was measured. The leakage under working conditions was closely approximated by jacketing the cylinder barrel and ends.

In all except the slowest or 50 revolution trials, a distinct reduction in leakage is noted when the sliding surfaces are well lubricated, over the corresponding leakage with scant lubrication. This effect is not, however, constant or very large; such a reduction was observed, however, in so many individual trials as to definitely prove that where the oil film is continuous and uniform, leakage is appreciably reduced. The curves given in Fig. 1 show this clearly, although the

reduction diminishes with increase of pressure. It may be noted that where in one instance the lubrication failed on the curve for the well-lubricated jacketed trials, the leakage at once rose above that for scant lubrication. The leakage, as would be expected, rises with an increase of pressure between steam chest and exhaust. The leakage increases approximately as the pressure where the valve is stationary in mid-position, but when the engine is running the leakage does not increase so rapidly as the pressure, and the higher the speed the larger does this divergence become. The conclusion is reached by the

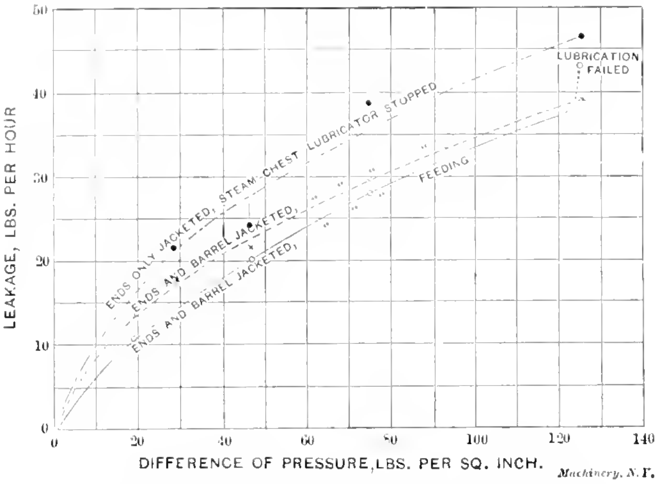


Fig. 1. Curves showing Leakage through Slide Valve to Exhaust.

author that much of the leakage must be in the form of moisture condensed on the valve face and re-evaporated as it passes over into the exhaust. Experiments were made as bearing upon the above, particularly to determine what effect wire-drawing and the consequent superheating of the steam previous to its entering the steam chest would have upon leakage, and a reduction of about 25 per cent. in the leakage was shown for the amount of wire-drawing used in the experiment.

The leakage is consistently less at the high speeds than at the low where the cylinder walls are jacketed and the surfaces lubricated. The difference between the leakage when the engine is stationary with the valve in mid-position, and when it is running, indicates that the amount of overlap and its variation has an important effect upon the leakage. Although the leakage is not directly proportional to the pressure for all speeds, and it is doubtful whether it is exactly inversely proportional to the overlap, yet these assumptions are sufficiently accurate to enable an approximate correction for leakage to be made by their use.

The leakage through the piston was measured by blocking the port at one end of the cylinder and running the engine single-acting. Cards of the working and blocked ends were also taken. It was found that the piston leak was independent of revolutions per minute, and was proportionate to the admission pressure and area of indicator diagram on the working side of the piston. The piston leak was found at its worst to be less than 2 per cent. of the steam consumption of the engine.

The general conclusions which have been drawn from these experiments may be summarized as follows:

Firstly, leakage through the slide-valve has been quantitatively determined under defined conditions, and has been shown to be nearly independent of speed of sliding surface and proportional to difference of pressure between the two sides of the valve. Further, it has been shown that the assumption that the leakage is inversely as the overlap of the valve is at least in the main well founded. And further that with well fitted valves the leakage may amount to over 20 per cent. of the steam entering the cylinder and is rarely less than 4 per cent.

Secondly, it has been shown that for an unjacketed engine with a given ratio of expansion initial condensation, expressed as a percentage of the steam in the cylinder, *diminishes* with increase of initial temperature, while the total condensation per stroke *increases* with such temperature increase. This, though suggested by Messrs. Callendar and Nicolson's researches, has never previously been demonstrated with clearness, as, if leakage is not allowed for, the results are obscured and even reversed, and the conclusions arrived at without leakage allowance are therefore unreliable.

Thirdly, it appears from the results here obtained that the re-evaporation for a given ratio of expansion is as great and sometimes greater without jackets than with them. This shows very clearly that the regenerative action of the cylinder walls with a given ratio of expansion is largely independent of their mean temperature. No quantitative analysis of re-evaporation is possible where leakage is not taken into account, as without the necessary allowance results would be largely illusory.

Fourthly, it is possible from the results obtained to show the temperature when for any speed of revolution with a given rate of expansion the jackets will become unnecessary or wasteful. If the heat units per I.H.P. per minute required by the unjacketed engine for each speed of the series be plotted either on an initial pressure or a mean effective pressure base the points for each speed will be found to lie on four curves, which become closer and closer to one another as the speed increases, and all converge to a point as pressure or temperature increases. If the heat consumption for the jacketed series be likewise plotted, it will be found that the points for the different speeds at each pressure lie irregularly round a point, their exact position being determined by the accidentally slight variations of the conditions of each trial. A fair curve through the means of these points will lie below the corresponding curves for the unjacketed trials, but if the heat absorbed in the jackets be included, the resultant curve cuts the unjacketed curves at points which for each speed indicate the temperature and pressure at which the jackets cease to be economical. Such curves are shown, plotted to a base representing initial pressure, in Fig. 2. It will be seen that the full black line, which is the resultant mean for the jacketed trials, cuts both the 250 and the 200-revolution unjacketed curves within the temperatures and pressures included within the scope of the present experiments, and the temperatures and pressures

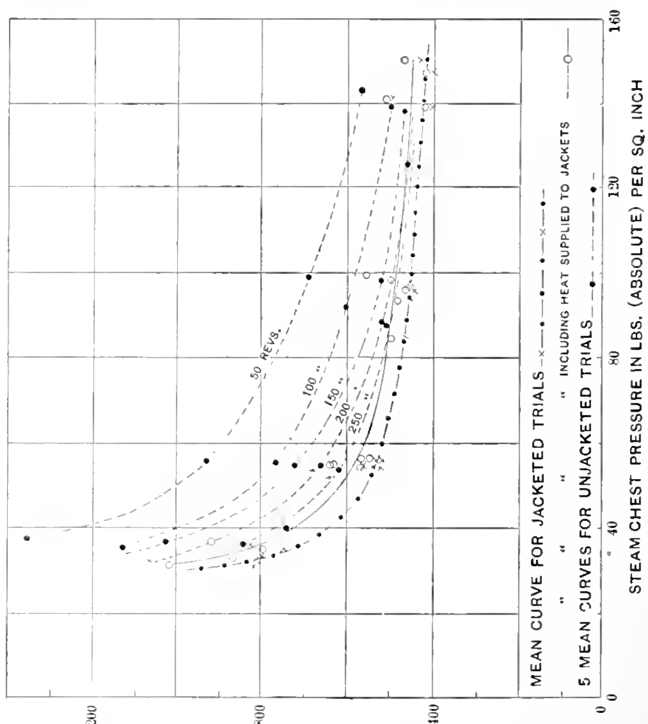


Fig. 2. Chart showing Heat Consumption for Various Conditions.

where the 150, 100 and even the 50-revolution curves would cut, can very closely be predicted. As far as the author is aware, this is the first time when an exact determination for a given engine and ratio of expansion of this point has been diagramatically shown.

In the discussion of this paper Mr. Longridge said that he would like to point out that the statement that the leakage varied according to the difference in pressure was not exactly in accordance with the results of the experiments. He said he thought that it would be found that instead of being proportional to the difference in pressure, the leakages were more nearly proportional to the square roots of the differences in pressure.

THE FORMS AND RELATIVE ADVANTAGES OF TEETH IN GEARS AS USED IN ROLLING MILLS.*

There are two curves chiefly used in designing the shape of gear teeth, namely, the cycloid and the involute. Their uses for this purpose dates back to the first quarter of the last century. Teeth shaped according to cycloidal curves are best for wear, but unless the pitch circles of a pair of wheels so designed meet exactly, the teeth will chase each other until they create their own shape. The advantage of cycloidal teeth over involutes lies in this, that in the former concave and convex surfaces come in contact, which affords a larger area of contact upon which to distribute the pressure than with involute teeth in which all surfaces are convex. With this form the area of contact is reduced to a line, and consequently the teeth are much more subject to abrasion than if the pressure were more distributed. However, the involutes, too, have an advantage over the cycloidals, namely, that in this form of teeth the pitch circles of a pair of wheels may be apart or overlap and yet not affect the good working of the wheels.

In well designed wheels the angular velocity must be uniform throughout the whole revolution of each pair of wheels. The teeth should be of proper strength at the root, and they should run without much noise.

Cycloidal Teeth.

The curves for these teeth are described by rolling a circle once on the convex and once on the concave side of the pitch circle. The curve thus produced on the convex side of the pitch circle forms the portion of the tooth projecting from the pitch circle outward, and is called "epicycloid," whereas the curve produced inside of the pitch circle forms the lower portion of the tooth, and is called "hypocycloid." The circles employed in developing these curves are called the rolling circles. The diameter of the rolling circle is of great influence upon the shape and strength of the tooth it produces. The smaller the diameter of the rolling circle, in proportion to the pitch circle, the thicker will be the tooth at its root, which means also greater transverse strength, and *vice versa*, the larger the rolling circle, the narrower and weaker will be the root of the tooth. But, wherever practicable, large rolling circles should be chosen because gears so designed have more teeth in simultaneous mesh, run more quietly, and the line of pressure in the middle position of two teeth in touch is nearer to a tangent at that point, than with a rolling circle of small diameter. The largest circle that may be used is one whose diameter is equal to the radius of the wheel, for in this instance the profile of the part of the tooth between the pitch circle and the root circle becomes a straight line, running radially from the pitch line to the center of the wheel, and if the rolling circle were made still larger, then that part of the tooth would be hollowed out and thereby weakened. In wheels that have little power to transmit, and especially if they run fast, the diameter of the rolling circle may be anything less than the radius of the pitch circle, but when the capacity to transmit power is the essential requirement, then the diameter of the rolling circle should be selected with due regard to strength, first and secondarily to quiet running. If a pair of wheels are of considerably different diameters, it is advisable to use rolling circles whose diameters are about in proportion to those of the wheels. However, this may be done only with wheels for some special machine, for neither of these wheels would work satisfactorily with one of the same pitch, but designed with the aid of some other rolling circle. Shops that follow the manufacture of wheels, as their specialty, make all teeth according to a standard rolling circle, whose radius is either a certain fixed fraction or multiple of the pitch, or equals the pitch. Gears so designed will work together no matter from what part of the world they come.

Gears with few teeth, for instance nine, must be designed with a small circle, otherwise the base of the tooth will be so narrow as to impair its strength. Professor Reuleux, who is a recognized authority on gearing, recommends seven-eighths of the pitch as radius of the rolling circles, and this ratio is adopted by many mechanical engineers and also by [illegible] in the manufacture of gears.

Fig. 1 shows a pair of wheels of respectively 30 and 60 inches diameter and 5-inch pitch. The teeth are cycloidal, but made by two different rolling circles whose radii are 5 and 10 inches or one equals the pitch, and the other is twice the pitch. In using different rolling circles, they are employed in this manner, that the larger one describes the root portion of the flank of the large wheel, and the upper portion of the flank of the small wheel, and conversely the small circle describes the root portion of the tooth of the small wheel and the top portion of the tooth of the large wheel. By examining this pair of wheels we notice first of all, that there are three pairs of teeth in mesh.

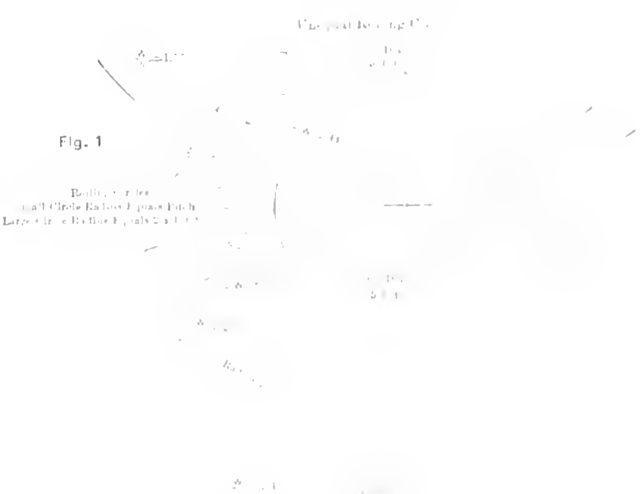


Fig. 1

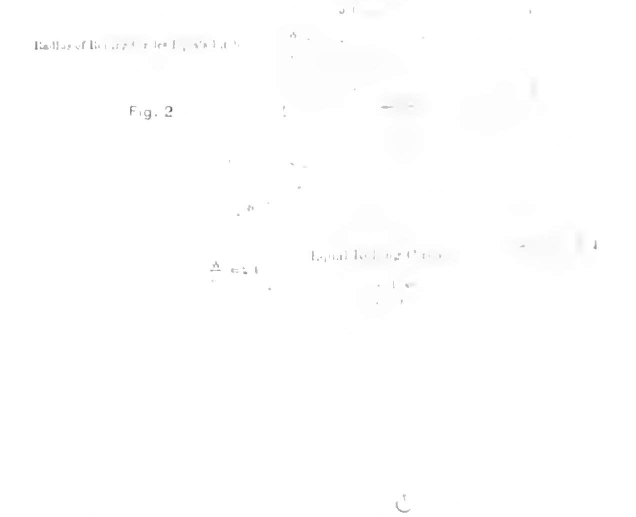


Fig. 2

In Fig. 1 the Teeth are produced by Rolling Circles of different Diameters for the Faces and Flanks. In Fig. 2 a single Rolling Circle is used

Fig. 2 represents the same pair of wheels, as far as diameters of pitch circles and the pitch are concerned, but the teeth of both wheels were produced with one and the same rolling circle. Comparing these two pairs of wheels we find that in the second pair there is only one pair of teeth in mesh, although the pitch and diameters are the same as in Fig. 1. This demonstrates the influence the diameter of the rolling circle has upon the shape as well as on the other properties of teeth. The wheels having three pairs of teeth in mesh must run smoother, hence with less noise and less wear than those with only one pair of teeth in mesh.

Fig. 3 shows three teeth on a 30-inch diameter wheel. Each tooth is of a different pitch, namely $3\frac{1}{2}$, 4 and 5 inches respectively. The rolling circles in each case have radii equal to the pitch. In examining these teeth as to their individual transverse strength, we find that the 4-inch pitch tooth is equal

* Paper read by Mr. Samuel Diescher, before the Mechanical Section of the Engineers Society of Western Pennsylvania, April 5, 1904.

in strength to the 5-inch pitch tooth. At first glance this looks odd, but is quite natural, for the coarser the pitch, the fewer teeth are in a circumference, and the more will they taper from the pitch circle toward the root circle, subject to the same rule as stones in an arch, which is, the broader the stone on top, the greater is the angle of taper. With the coarseness of the pitch grows also the height of the tooth. The transverse strength of a tooth grows with the square of its thickness at the root and inversely with its height, or bending moment. For this reason if in any particular instance the wheel diameter

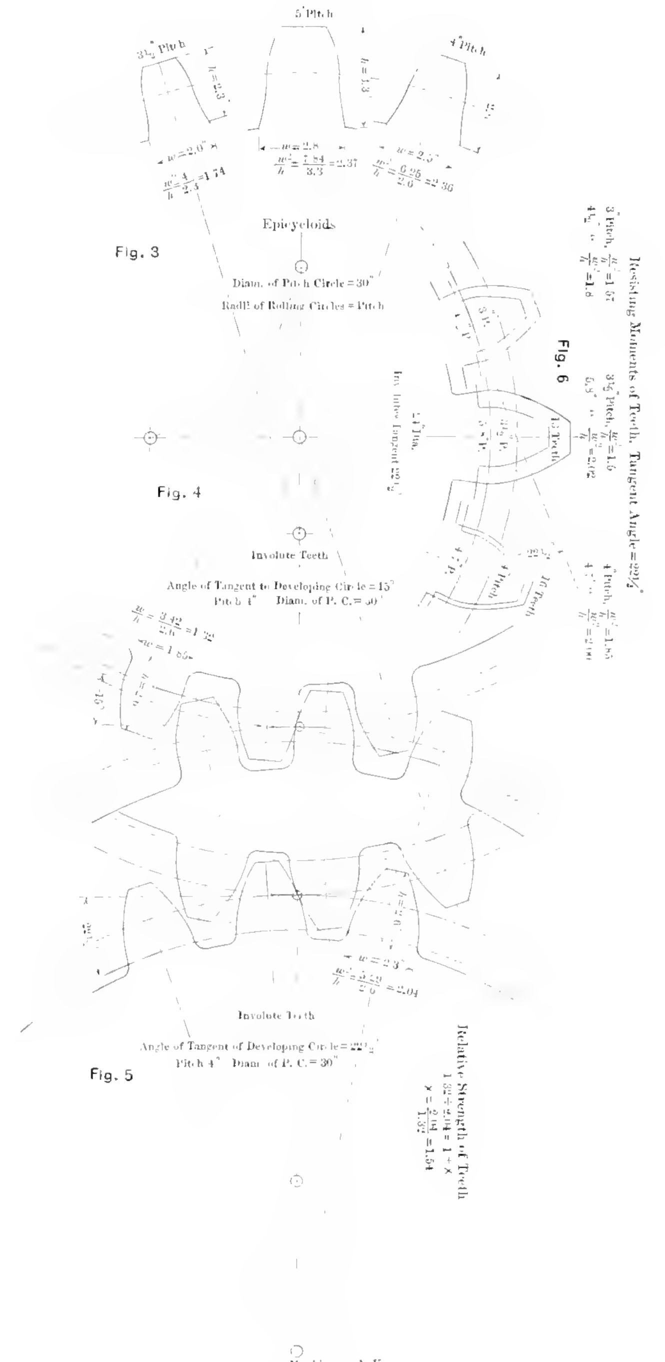


Fig. 3, shows Relative Strength of Teeth of Different Pitch, but with same Rolling Circle.
Fig. 4, a pair of Wheels with Involute Teeth.
Fig. 5 shows Teeth laid out with Path of Contact making Anglee of 15 and 22 1-2 Degrees respectively, for the two sets of Teeth.

is given and a tooth is to be determined to give the greatest strength of tooth with the greatest number of teeth in the wheel, it will be necessary to figure it out, and not to rely upon the thickness of the tooth in the pitch lines, for that is deceiving.

Fig. 4 represents a pair of wheels with involute teeth. The wheel diameters are both 30 inches and the pitch is 4 inches. The angle of the tangent of the developing circle is 15 degrees. This angle is almost universally adopted as the standard tangent angle for developing circles, and it has precisely the same influence upon the harmonious working of involute teeth as the rolling circle in relation to cycloidal teeth. By examining these teeth we find here, too, that only one pair of teeth is in mesh. Of course, there are positions of the wheels in which two pairs will mesh, but only for a short interval. However, for comparison, we must note that all of the wheels here shown are represented as standing in a middle position, that is, a line drawn through the two wheel centers passes also through the point of contact between one pair of teeth. As to the comparative transverse strength of cycloidal and involute teeth of the same pitch, 4-inch, in wheels of the same diameter, 30 inches, we find by a calculation that the strength of the cycloidal tooth is to that of the involute tooth as 2.36 is to 1.5.

There are occasions when wheels of especial strength of teeth are required, for instance, in rolling mill gearing, particularly in mill pinions. The latter are usually designed with very coarse pitch with the aim of insuring great strength. For the reason of heavy wear in the bearings and journals of mill pinions and the contingent parting of the pitch circles from each other, the involute teeth are more satisfactory than those of cycloidal form, but in order to impart to those teeth greater strength than standard teeth would have, the angle of the tangent to the developing circle is made greater than 15 degrees. Thus in some of the larger plants about this city, an angle of 22½ degrees is adopted as the standard for mill pinions, and at the Carnegie Mills, as much as 28 degrees.

In Fig. 5 we see a pair of 30-inch wheels with 4-inch pitch, and 22½ degrees angle of tangent. By comparison we see that these teeth are much stronger than the same teeth at a 15-degree angle, though every other dimension is the same in both cases. We find also that here too, only one pair of teeth is in mesh. Furthermore, we find that in Fig. 5 the line of pressure through the point of contact is much less normal to the line drawn through the wheel centers than in Fig. 4, and therefore a greater pressure is exerted toward the journals and bearings than in the former instance. Concerning the strength it is to be said that according to calculation, the strength of tooth in Fig. 4 is to that in Fig. 5, as 1.5 is to 2.3, or the tooth in Fig. 5 is by 53 per cent stronger than that in Fig. 4.

In Fig. 6 we see 6 involute teeth in a 24-inch diameter wheel, and angle of tangent of 22½ degrees. These teeth are of different pitches, namely, 3, 3.5, 4, 4.5, 4.71 and 5.8 inches. The latter pitch corresponds to 13 teeth, the standard number adopted for all mill pinions in one of our largest manufacturing plants in Greater Pittsburg (National Tube Works, McKeesport), whether their diameters are large or small. It is difficult to see why any fixed number of teeth should be adopted for all sizes of wheels.

The pitch 4.71 inches is introduced here for comparison because it gives 16 teeth against 13 of the 5.8 inches pitch. A wheel with 16 teeth runs smoother than one with 13 teeth. The strength is determined by the quotient derived by dividing the square of the thickness of root by the height of the tooth. Accordingly the relative strength of these teeth is as follows:

3-inch pitch, 1.57; 3.5-inch pitch, 1.50; 4-inch pitch, 1.85; 4.5-inch pitch, 1.80; 4.71-inch pitch, 2.0; 5.8-inch pitch, 2.02. Hence 4.5-inch is to 5.8-inch as 1.8 to 2.0 and 4.71-inch is to 5.8-inch as 2.0 to 2.0.

The pitch of 4.71-inch gives 16 teeth of the same strength as the teeth of 5.8-inch pitch, of which there are only 13 teeth in the wheel of the same diameter as that of 16 teeth.

* * *

A prominent electrical dealer from Texas recently visited St. Louis, and took the opportunity to look through the Emerson Electric Mfg. Co.'s factory. After being duly impressed by the activities of the machine shop, the press rooms, the assembling department, and the testing force, he came to a stop before the machine of a workman winding a small direct current motor armature. The machine was started, the coil wound, tied, pushed in and wedged, the leads brought out, and the operation repeated several times; still his interest did not flag. At last the visitor pulled out his watch. "One minute and thirty-five seconds per coil," he thoughtfully announced. "And in Texas we get $12.50 for rewinding an armature like that!"

LETTERS UPON PRACTICAL SUBJECTS.

DIES FOR MAKING TIN NOZZLES.

Editor MACHINERY:

In this article is shown a set of dies for the production of nozzles for tin cans of large sizes used to ship liquids. The dies are of the combination type used in single action presses and do from one to three operations at one stroke of the press. From 12,000 to 15,000 pieces of finished work can be turned out per day from these dies according to the speed of the operator.

The first die, Fig. 2, is composed of five principal parts: *A* is a gray iron bolster plate made to separate at the line *a-b* so the die can be readily taken apart for repairs. *B* is

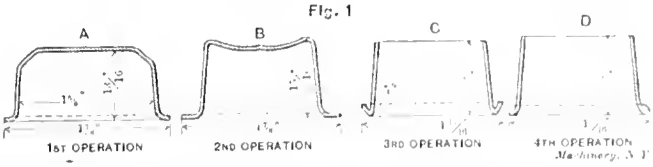


Diagram of Operations in making Nozzles for Tin Cans.

the "cut edge" set into the top plate and held down by three flat-head screws (not shown). *C* is the center block set into the lower plate of the bolster and also held in place by flat-head screws, not shown. *D* is the pressure ring or blank-holder which rests on three pins (one shown) which in turn are supported by the washer *E*, which rests on the rubber spring surrounding the stud *F*, and held in place by another washer and nut (not shown) with which to regulate the pressure while drawing the shell. *G* is the punch and drawing die combined, the outside diameter of which is fitted to the cut-edge *B*. The inside diameter is fitted to the center block *C* plus twice the thickness of metal. *H* is a forming pad made to fit the top of the center block *C*. It forms the top of the shell at the end of the stroke and also serves as a knock-out for the shells.

In operation the tools are set into an inclined press. The punch coming in contact with the cut-edge *B*, cuts the blank, which is held by the pressure ring *D* against the end of the punch *G*, but as punch *G* continues down the blank is drawn over the center block *C*; and as the punch ascends the stem *I*

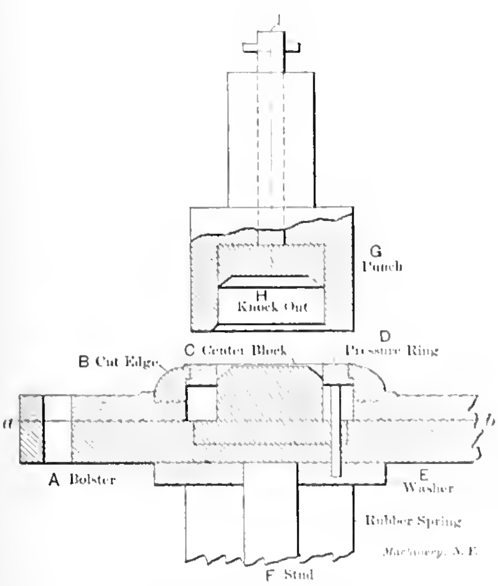


Fig. 2. The First Die.

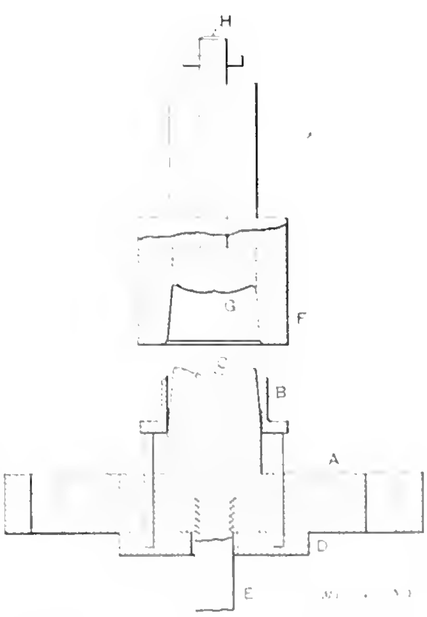


Fig. 3. Redrawing Tools for the Second Operation

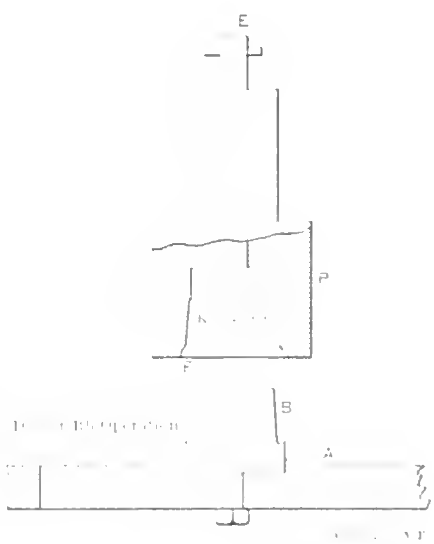


Fig. 5. Tools for the Finishing Operation

in the top of the punch shank comes into contact with a bar in the press pushing the pad *H* down, and the shell represented at *A*, Fig. 1, slides off back of the press.

Fig. 3 shows the second operation or redrawing tools. *A* is the bolster plate. *B* is the drawing ring, supported by pins and a rubber spring, the same as in Fig. 2. The center block in this die is tapered and the punch *F* is also bored out tapering to fit it. The pad in punch *F* is of peculiar shape, as will be noticed and will be explained later. The shell is placed

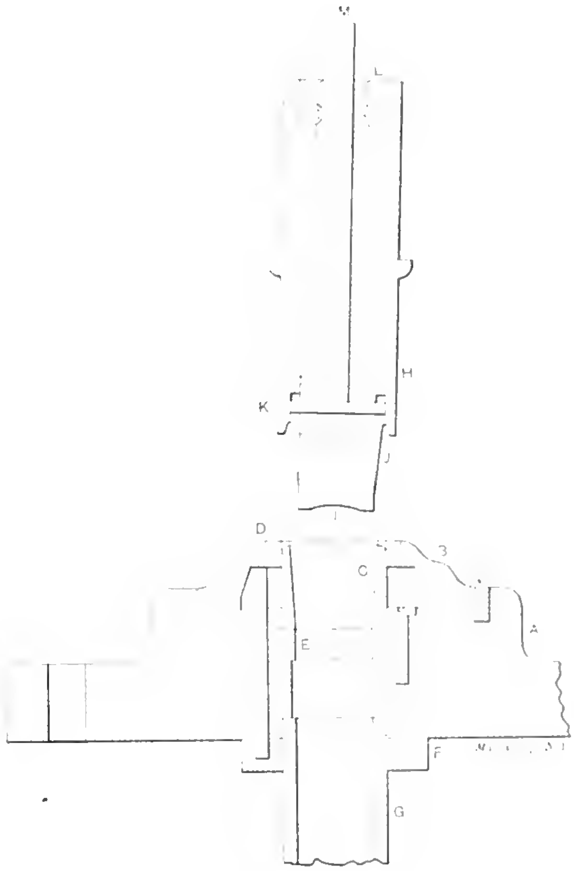


Fig. 4. Tools for the Third Operation

on the drawing ring and the punch as it descends draws it down and compresses it to the shape of the center block *C*. The shell is knocked out on the up stroke by the stem *H*, same as in the first operation and the drawn piece looks like *B*, Fig. 1.

Fig. 4 shows the tools for the third operation, which really consists of three operations. *A* is the bolster plate of the die; *B*, the trimming die; *C*, the center block; *D*, the drawing ring, *E*, the lower die; *F*, washer; *G*, tube through which the bottom of the nozzle passes after being punched out. These bottoms are used for roofing shells for fastening tar paper in place on roofs, etc., so that in the process we really make two articles at once. These tools are used in an inclined press. As the punch comes down punch *I* cuts the bottom out, and at the same time punch *H* trims the lap edge; as it con-

tinues on down it presses the shell over the edge of the center block C. As the punch ascends the knock-out bar comes in contact with the pin M, carrying the stripper J down by the cross-pin K and ejecting the nozzle in the shape of C, Fig. 1.

Fig. 5 represents the tools for the fourth and finishing operation. It consists of a simple punch and die, yet much depends on these tools, for the nozzles all have to be of an exact size on the finished edge to receive a sealing cap and this cap when closed on has to be watertight. The die consists of a bolster-plate A and a die-block B, made of tool steel, hardened and tempered. The punch is also hardened and tempered and ground out to gage. The tools are set in the press, the nozzle is slipped on the die-block. The punch D in coming down passes over the work until the edge turned up on C, Fig. 1, comes in contact with the shoulder F on the inside of the punch. As the punch continues on down this edge is curled over and pressed down to the shape of D, Fig. 1. As the punch rises the shell is knocked out by the knock-out stem same as in all the other dies.

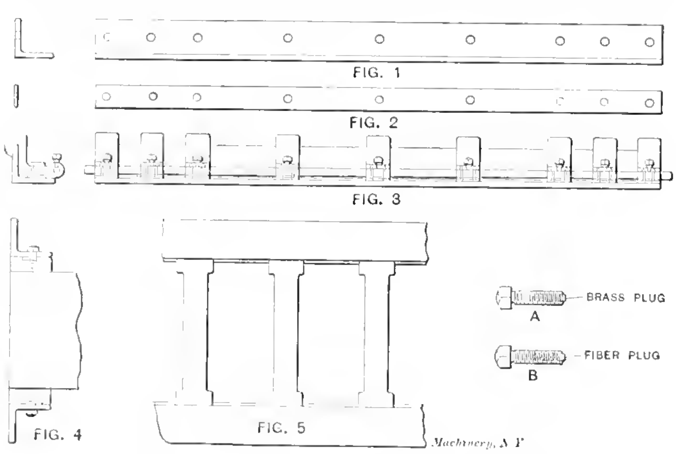
These dies are "all round" dies, so they are not so hard to make as would be the case if they were of an irregular shape.

At the same time I have met men who seem to think that it does not require any *good* tools to produce a tin can, but my opinion is they would change their minds if they had to produce some of the tools themselves, for the tools require the utmost accuracy in points of construction, besides tin is a very peculiar metal to handle in dies. PRACTICAL.

JIG FOR DRILLING ANGLE AND STRAP IRON.

Editor MACHINERY:

The inclosed drawing represents a method of drilling angle and strap iron which gives most satisfactory results when the quantity of work to be done does not warrant the use of a punch and die. The pieces to be drilled are used as the frames for mounting the cast-iron resistance plates of a field regulating rheostat. Each plate is fastened to the frame by the holes tapped in the four lugs which are cast with a recess to receive the strap iron and over this the angle iron as shown in the assembled sketch, Fig. 4. As the capacity of the rheostat may be increased by adding more resistance plates, it was found necessary in the design of the drilling jig to make provision for drilling six different lengths of angle iron with the corresponding different layout of holes. The jig itself is shown in two views in Fig. 3 in position for drilling. The pieces which fit over the angle iron and hold the bushings which locate the holes are made of cast iron in the shape shown in the end view of Fig. 3. To facilitate setting them the required distances



Details of an Adjustable Drill Jig for Long Strips.

apart they were finished exactly one inch wide. They were securely held in this position by means of the setscrews bearing on the long bar of cold rolled shafting. These same pieces were used for drilling all lengths of angle iron by varying the length of the round iron bar which holds them. The recess milled across the bottom of each of these small jigs was for the reception of the ¼-inch strap iron which was laid on the angle iron and drilled through at the same time. In this respect it is curious to notice how the best intentions of the designer and toolmaker are sometimes defeated by the ignorance or carelessness of the operators using the jigs. It is an actual fact that about sixty of these frames were drilled, first the angle iron and afterward the strap iron, whereas it had been expressly provided that both should be drilled together. To prevent the jig from moving along while the holes were being drilled the angle iron, strap iron and jig were held together with a cap screw and nut after drilling the end hole. Beside the saving shown in the drilling operation the cost sheets showed a saving of from 15 to 25 per cent in the cost of assembling the plates, thus giving us the benefit of quite an economy over the older method of laying out by hand and drilling to a center punch mark.

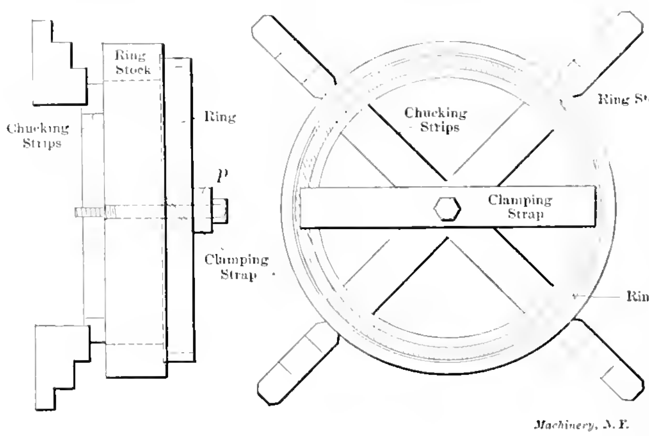
A word of explanation is necessary regarding the use of setscrews on this jig. This was found to be the only objectionable feature and while it must be considered as a necessary evil still in this case the injurious effect of the screws on the shaft was minimized by driving a piece of brass rod into a hole drilled in the end of the screw, as shown at A. By protecting the point of the screw in this fashion it may be used in many places where otherwise it could not be allowed. When, for instance, a setscrew bears against slate, marble or any soft material a tip of red fiber screwed into the end, as shown at B, answers the purpose better than brass. Because of the shrinkage it is difficult to maintain a permanent driving fit in the fiber and it must therefore be screwed in. As the brass and fiber are fastened to the screws they may be taken out without the necessity of fishing for the small separate piece of protecting material usually used. H. J. BACHMANN.

New York.

RIG FOR RE-TURNING PISTON RINGS.

Editor MACHINERY:

I have seen several ingenious devices in MACHINERY for returning piston rings to make them fit the bore of the cylinder. The only objections I have ever found with them was that they were only applicable to a certain diameter of ring; and for a shop which has only a few rings of various sizes to turn, the cost hardly warrants the making of a device unless it is cheap and can be made quickly without any special castings. For such work I have used the following kink with success:



Device for Re-turning Piston Rings of Various Sizes.

After cutting off the last ring, turn a shoulder in the remnant of ring stock 1-64 inch larger in diameter than the bore of the cylinder and 1-32 inch deep. These dimensions will vary with the diameter and stiffness of the ring, but will be found to be about right for an eight-inch bore. Drill and tap the chucking strips on the ring stock for a capscrew.

The rings should then have a piece cut out in the usual manner until they will just slip in under the shoulder turned in the ring stock, with the ends coming together. A cap screw and a clamping strap to clamp the ring in the recess in the ring stock complete the rig. With this rig the rings may be turned to fit the bore of the cylinder, as far as the ring stock will permit. The smaller unfinished portion of the ring can be quickly filed off. If the ring stock have no chucking strips to tap for the cap screw the clamping strap may be bolted to the chuck. STANLEY GOULD.

Los Angeles, Cal.

AN INGENIOUS MECHANICAL MOVEMENT.

Editor MACHINERY:

During a recent visit to a firm engaged in a branch of the leather business, the writer noticed a machine which made use of a very interesting mechanical movement, new to him at least. In operation the machine gives the product a series of powerful squeezes, and then opens up the dies to allow the removal and insertion of the work. Figs. 1 and 2 show the working and open positions respectively of the mechanism which performs this duty.

The ram g which carries one of the two dies, a, is reciprocated by the eccentric j, which is keyed to the shaft l. This shaft turns in the direction shown by the arrow, and is driven by tight and loose pulleys at i. The upper half of the eccentric strap is pivoted to the connecting rod at d, and carries an arm h to which is hitched the long spring b. If there were nothing to prevent it, the spring would evidently tend to pull the joint d over as shown in Fig. 2. In this position, with the belt on the loose pulley, the machine is ready to receive the work; k and k are the lugs of a leather band friction, bearing on an extension of the eccentric surface, and shown in dotted lines behind the eccentric strap. A finger screwed to the lower half of the strap and projecting between the lugs serves to keep the brake in position. If the machine be now started by throwing the belt onto the tight pulley, the brake grips the eccentric with sufficient force to overcome the slight tension of spring b, and joint d is moved back again to a central position bringing the parts into the position shown in Fig. 1, where buffer e has reached its seat on the connecting rod.

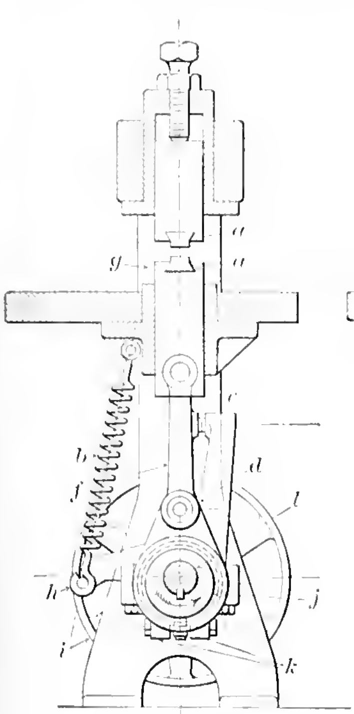
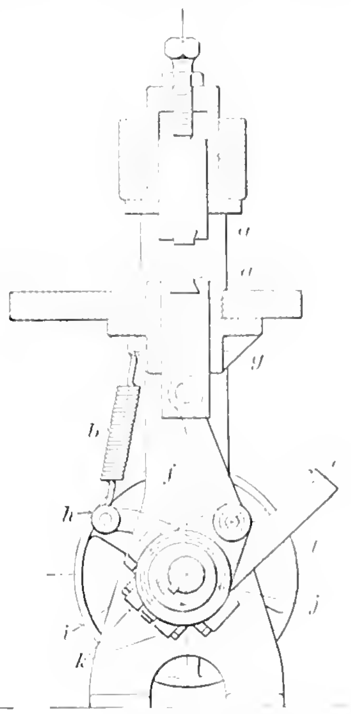

WORKING POSITION

Fig. 1.


OPEN POSITION

Machinery, N.Y.

Fig. 2.

The shaft continuing to turn, brake n slips on its seat, and the eccentric gives the desired movement to the ram. When the operation is completed, the belt is slipped to the loose pulley, and spring b turns the shaft, eccentric, and strap backward until the machine is again open, with the ram lowered to allow a change of work.

The writer does not know if this device is patented, or patentable, but it may prove suggestive to someone who has a similar problem to solve.

RALPH E. FLANDERS.

Malden, Mass.

FORMULA FOR PLANING THREAD TOOLS.

Editor MACHINERY:

I give herewith diagram and formulas for thread tools, with special reference to those used in a Pratt & Whitney thread tool holder, same holder being the one considered the best and mostly used by leading firms. As the planing of thread tools used in above holder is rather particular and quite confusing to those not familiar with same, I have given formulas by means of which the angles, to which the planer or shaper head should be set, can easily be figured. The formulas will be readily understood from the diagram, but a word may be needed in explanation of "the leading" and "the following" side of the thread tool, the former being that side of the tool first entering the work when a thread is cut.

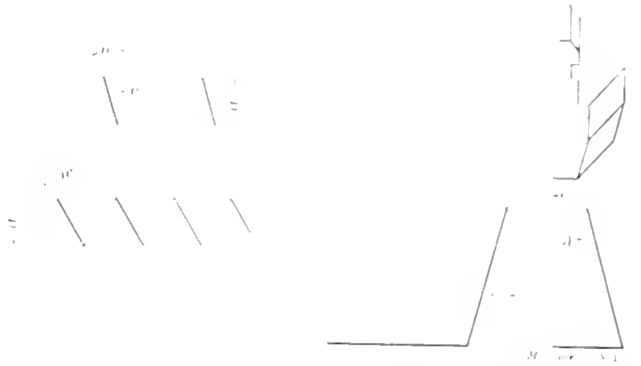


Diagram Illustrating the Planing of Thread Tools

1. Tool with Side Clearance.

a = depth of thread.
b = width of flat on offset tool.
c = actual width of flat.
d = outside diameter of screw.
v = clearance angle.
w = ½ angle of thread.
y = angle of helix.
x = normal angle (to which to set planer head, when planing tool on side).

$$\tan y = \frac{\text{Lead}}{(d - a)\ 3.1116}$$

$$\tan x = \frac{\cos y \pm (\cot w \times \sin v \times \sin y)}{\cot w \times \cos v}$$

Use + for leading side and — for following side.

For Acme (29°) thread and 15° clearance angle, the formula can, for all practical purposes, be written:

$$\tan x = \frac{\cos y \pm \sin y}{3.735}$$

The width of flat on the offset tool is figured from the formula: $b = c \times \cos y$.

2. Tool without Side Clearance.

If the tool has no side clearance, the angle of helix can be considered = 0°, and above formula reduces itself to: $\tan x = \dfrac{\tan w}{\cos v}$; for 60° screw thread, United States standard, the formula has this appearance: $\tan x = \dfrac{\tan 30°}{\cos 15°} = .5977$; $x = 30°\ 52'$.

In this latter case the width of flat of tool (c) remains unchanged.

It will be noticed that formulas are given first for "tools with side clearance" and second for "tools without side clearance"; of course any thread tool ought to be given a side clearance, the amount of which depends on the angle of helix of thread to be cut, but on account of the small angle of helix on fine pitch threads, the necessity of using a tool with side clearance in such cases is reduced to a minimum, and can for practical reasons be dispensed with.

A. L. VALENTINE.

Hartford, Conn.

A NOVEL DRILL PRESS ATTACHMENT.

Editor MACHINERY:

The piece of work illustrated in the two views, Fig. 1, was of tool steel cut from the bar and milled all over to exceedingly accurate dimensions after which it was further machined at C to the shape shown. It was necessary that the point C have a radius of exactly 3-16 inch with its largest diameter exactly ⅜ inch. To facilitate the accomplishment of this somewhat difficult machining rapidly and cheaply, and at the same time to insure the production of perfectly interchangeable parts

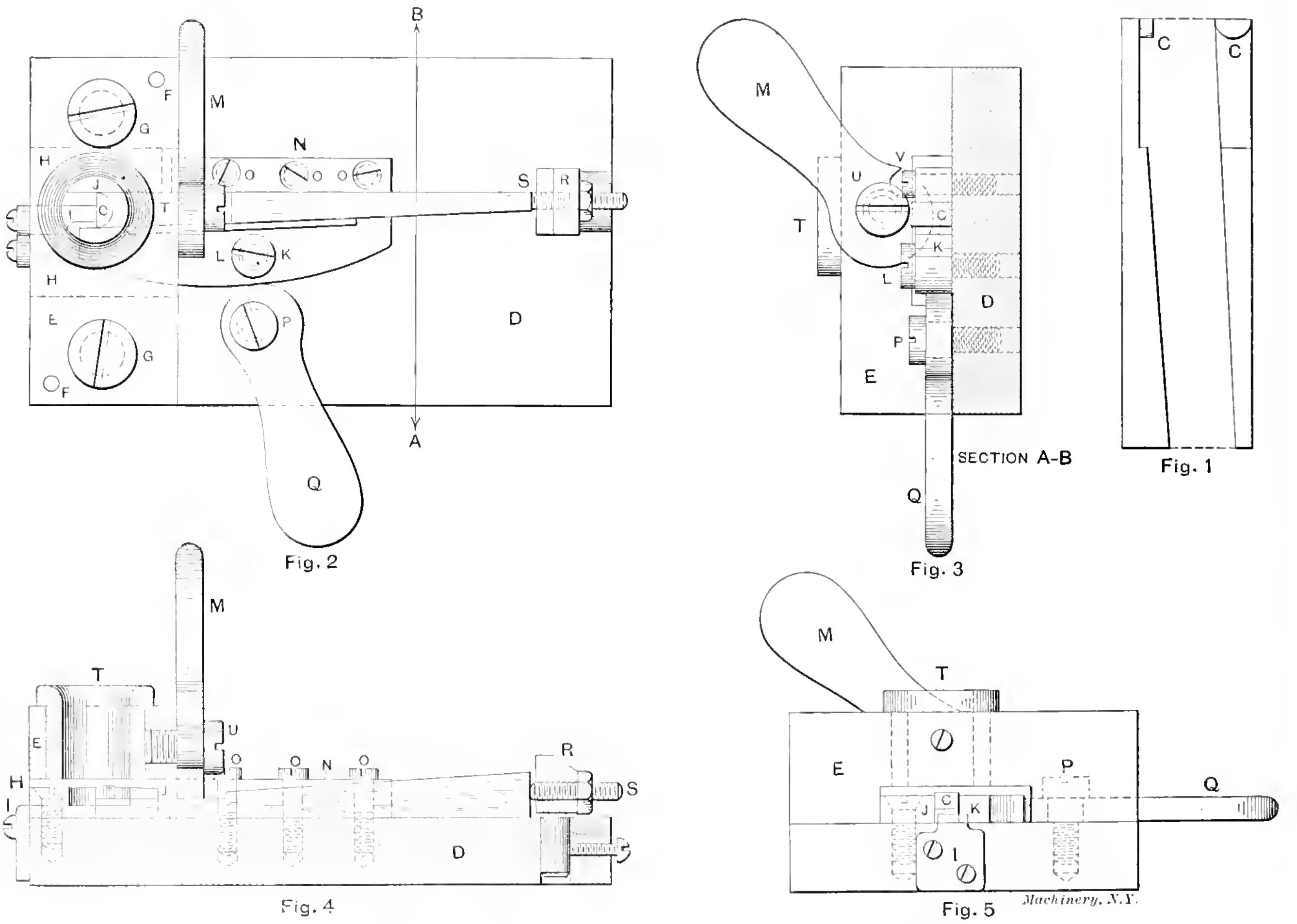
through the operation, the fixture illustrated in Figs. 2, 3, 4 and 5 was designed and used. The four views of the jig comprise a plan, Fig. 2, a vertical cross section, Fig. 3, a longitudinal section, Fig. 4, and an end view, Fig. 5, and they should make the construction of the various parts and their working functions when assembled quite clear.

D is a cast-iron base block upon which, at one end, a machine steel block *E* is located and fastened by two flat head screws *G* and dowels *F*. A square channel or clearance way is let through at *H*, to allow of locating suitable stops and entering the work beneath the cutting tool. *I* is a stop or end locating piece against which the work *C* is located. *J* is a side support for the work with a section worked out to a radius equal to that of the outside diameter of the cutting tool. *N* is the positive-side banking piece fastened to *D* by the screws *O*. *K* is the clamping side piece which has a slotted hole permitting of limited movement under the shoulder screw *L*. *Q* is the eccentric clamping lever swinging on shoulder screw *P*, which is used to force and hold the clamp *K* tightly against the work. *R* and *S* form parts of the adjustable stop for the end of the work to locate against. The means used for clamping the work down into its seat in the jig are very simple and effective. By simply pulling the eccentric lever *M*, swinging on shoulder screw *U*, upward, the work is secured; by forcing it down, the work is instantly released and may be pulled out through the clearance channel or notch in the lever shown at *V* in Fig. 3.

The following explains the use of the jig, and the manner in which the work is machined to the shape and size shown at *C*. A cutting tool of the hollow mill type, the outside of which was left plain and the same diameter as the hole in the guide bushing *T* was made for the drill press spindle. The jig is placed on the drill-press table, the levers *M* and *Q* are released, the work is inserted and located against the stop as shown in Figs. 2 and 4, the lever *M* is pulled up and then lever *Q* pulled out, whereupon the work being securely located and fastened within the fixture and against the positive stops, the hollow mill is fed down into the bushing *T* until the part *C* of the work is machined to the shape and size required. In order to insure the production of clean, well-finished, and accurately surfaced work, the cutting tool had to be carefully and accurately made and its cutting edges well stoned at regular intervals.

JOSEPH V. WOODWORTH.

Brooklyn, N. Y.



A Drill Press Jig for Milling the Semi-circular End on the Piece in Fig. 1.

LOOSE PULLEYS.

Editor MACHINERY:

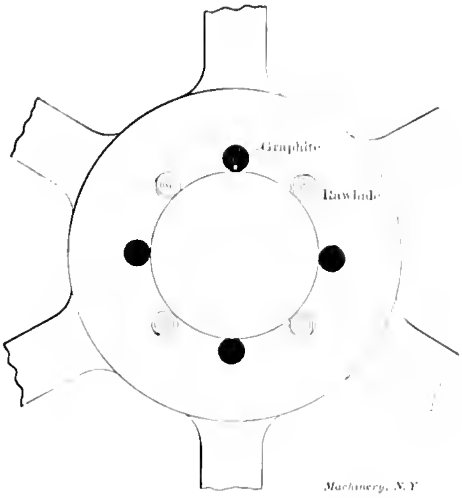
Of all known mechanical devices the loose pulley has probably caused more navy blue profanity first and last than all the others put together. There are very few of us in the mechanical line who have not at frequent intervals come into violent contact with the loose pulley of commerce. Now I ask you, my friends, why so crude a thing is put upon the market? You reply, because there is no substitute for it as yet. In other words, it is made cheap because it is sold cheap in order to compete. But the results of its use are far from cheap if we did but know it.

Now, during my twenty-eight years of mechanical experience I have never seen a loose pulley that proved to be a complete success. Far from it! All machinery requiring loose pulleys that I have so far designed, I am sorry to confess, follows, as far as the pulleys are concerned, the time-honored custom; that is, a simple hole drilled through the hub to the bearing and a wooden plug inserted to retain the oil and keep out the dust. It seems strange that a man of my experience should accept such a makeshift design as final and embody it in the construction of new machinery, which in my case is all special and therefore the fault is less excusable. My defense is that I am following an almost universal practice of the present time, which shows a lack of thought on this important subject.

Shall the loose pulley of the future be designed to run wet or dry, is the first question; but there is no question as to how most of them do run at the present time. It brings a well-known fact that they run dry mostly, hence the trouble. Therefore it would seem, not being able to keep oil in them for any length of time, that the only remedy would be to so design them as to run properly without oil. That is, perfectly

dry. It is obvious that this result can be accomplished by substituting rolling friction for sliding friction through the use of ball bearings. But this would be too expensive, says the manufacturer, holding up his hands in holy horror; it would ruin my business. I could not compete successfully with the time-honored device of my competitors. Therefore the application of ball bearings to loose pulleys must, to succeed, be universally adopted by makers of machinery.

Now the only other practical way that remains to be considered is to return to sliding friction. But instead of trying to use oil as a lubricant we will fill inner sections of the hub with dry lubricant such as graphite or a substance of like nature interposed with like sections of rawhide or asbestos fiber.



Design for Dry-lubricating a Loose Pulley.

The lubricating and antifriction material could be forced into these cored holes from the end of hub very nicely, as the holes run clear through from end to end of hub, or in other words, are open at both ends. After the rough casting has been filled with the antifriction material and allowed to dry hard the hub is bored out the right size and the pulley otherwise finished complete the same as usual. Now in boring out to size it will be noticed the main or shaft hole cuts into the series of small cored holes surrounding it, thus laying bare narrow sections of the lubricating material, the whole length of bearing, alternating with graphite, cast iron, rawhide, cast iron, graphite, cast iron, and so on around. Between the hubs of the tight and loose pulleys and also between the hub of the loose pulley and collar there should be interposed a thin rawhide washer, thus making a loose pulley of great durability and cheapness and requiring no attention whatever.

BRISTOL.

THREE-PIECE ELLIPSOGRAPH AGAIN.

Editor MACHINERY:

In the March issue Mr. Charles G. Taylor suggests two improvements in regard to the "Three Piece Ellipsograph" which I described in the November (1904) issue. The first improvement I need not mention as Mr. Taylor himself says that the second is the better, and consists of using "but the one screw, making some modifications in its shape and application." If Mr. Taylor had appreciated the fact that I was not describing some theoretical proposition, but telling of a model that we actually built and had in actual operation, he might have realized that the single wood screw which I had in the center of the apparatus was there for the identical selfsame purpose as the fancy fillister head screw which he suggests as being, "a still better plan." Mr. Taylor seems to have gotten the idea into his head I got hold of that screw and tightened it to such an extent that the apparatus could not work, for he states, "Now if this screw is screwed in tightly, Fig. 3 cannot move." Of course it couldn't; who would expect it to? It seems to me that at first Mr. Taylor failed to grasp the "*modus operandi*" of the apparatus and when the idea eventually "filtered" he mistook it for something new and accordingly sends it in as a "still better plan."

In regard to the minor improvements which Mr. Taylor suggests, they hardly warrant further discussion as no one would seriously consider an ellipograph made of wood for practical work. However, I might add a word in regard to Mr. Taylor's last suggestion, viz., "In using this device, the top circular plate should be lifted off and Fig. 2 moved the distance off center required for the radius of the longer diameter of the ellipse. The screw should then be tightened and the top plate put on." It seems to me that any adjusting device that requires the removal of the pencil or tracer, the removal of the top plate and replacing the same, and then re-adjusting the pencil, as Mr. Taylor's idea requires in order to change the ellipse, when the same end could be attained without disturbing anything, by merely drawing out Fig. 2 and clamping it in the required place, is about as undesirable a feature as one could conceive of. It would be about as ridiculous as an elliptical lathe chuck where we would have to remove the tool from the tool-post, remove the work and the faceplate, make the required adjustment and then replace everything.

Phœnix, Ariz. JOHN D. ADAMS.

BUSHINGS FOR DRILLING AND REAMING JIGS.

Editor MACHINERY:

The accompanying table of drilling and reaming jigs gives the dimensions, as per diagram, that have been adopted as standard by a large manufacturing concern in Chicago. It will be noticed that the shoulders are much smaller than generally used, and in my estimation there is no need for the shoulder of a loose or removable bushing to be larger than is necessary for a good finger hold. By keeping the shoulder dimensions down to the figures given in the table, a considerable

BUSHINGS FOR DRILLING AND REAMING JIGS.

D	A	B	C	E	D	A	B	C	E
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1	1	1	1	[illegible]					
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1 [illegible]	1 [illegible]	2	1 [illegible]	[illegible]					
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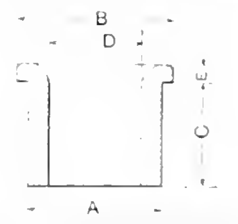


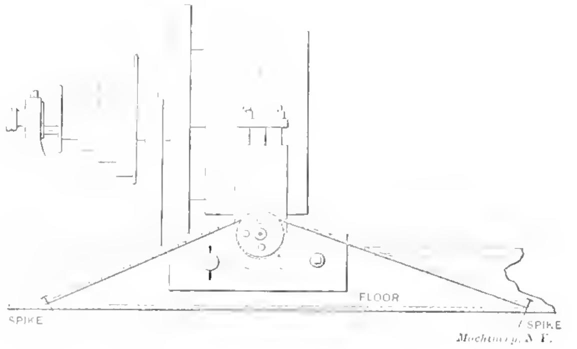
saving of steel is effected in the larger sizes, and when this amount is multiplied by the thousands of bushings necessary in the works referred to, it becomes a very important matter. Another feature of economy in making these bushings is the use of machine steel, casehardened, which gives as good results for this work as tool steel, and of course is far less costly both in price per pound and in time required for working.

Chicago, Ill. O. C. BORNHOLT.

PULLEY CROWNING DEVICE.

Editor MACHINERY:

A number of years ago when I was much younger than I am now, and machine shops did not have special tools for doing work as they have at present, I had a job of boring and turning a number of large pulleys, with only an ordinary 72-inch lathe, and very poor appliances for handling them. These pulleys would just swing over the carriage and were about 20 inches face, and had to be turned crowning. The only way to do them was to chuck them on the face plate, bore them, take a cut across the face, take them out of the lathe, drive a mandrel into them, and finish them on centers. That was a lot of work and took some time, moreover, as there was no reamer to size the pulleys and they had to be bored very close in order to be able to use one mandrel for all of them. I think about a dozen altogether. So while boring the first pulley I figured how I could save time and labor on the job, and I hit on the rig I have sketched.



Pulley Crowning Device.

First I found out what part of a turn the screw on the cross-feed had to make to get the desired crown while the tool traveled over half the face of the pulley, and I hunted in the scrap and stock pile for a pulley large enough to turn the screw sufficiently far to feed in the proper amount. I also hunted up a piece of rope that would not stretch much, taking finally a braided rope about 20 feet long, such as is used to drive portable drills, etc., and tied a loop in each end. I drove a spike in the floor in line with the pulley which had been fitted on the cross screw in place of the crank hands, took one turn around the pulley with the rope, and, after fastening a close coiled spring a foot long to one end of the rope, drove another spike in the floor on the other side of the carrriage the proper distance so that when the rope was connected to both spikes and turned once around the pulley, the spring put tension enough on the rope to keep the pulley from slipping while the carriage moved. I put the spring on the end toward which the carriage traveled so that there was no give to the rope, and when I wanted to run the tool the other way I just changed ends with the rope, which was very easy owing to the spring. I know that there are several ways of accomplishing the same object, but I think this way has several good points, one of which is that it may be used without much expense.

Milwaukee, Wis. THEODORE DISCH.

ANISOMETRIC PROJECTION.

Editor MACHINERY:

This is a variety of axonometric or triaxial projection, in which all lines that are parallel in the object represented are parallel in the drawing; also, the value of all lines in the direction of any one axis may be measured on one and the same scale, but for each axis a different scale is needed.

Proportions of the Axes.	Angles made by the Non-vertical Axes with the Projection Axis AB.	
1:0.5:0.9	17° 49′	5° 11′
1:0.5:0.75	8° 51′	2° 51′
1:0.75:0.875	24° 46′	16° 59½′
1:0.4:0.95	24° 22′	3° 49½′
1:0.33:0.95	13° 32½′	1° 36½′

Foreshortening of the Axes.			Natural Sines of the Angles made by the Non vertical Axes OY, OZ, with the projection Axis AB.	
OX	OY	OZ		
0.9853	0.4927	0.8868	0.3060	0.0903
0.9961	0.4981	0.8716	0.1539	0.0497
0.9269	0.6951	0.8110	0.4189	0.2922
0.9847	0.3939	0.9335	0.4126	0.0666
0.9966	0.3322	0.9468	0.2313	0.0281

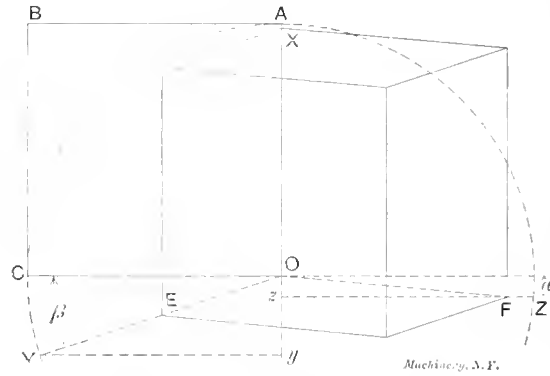
Tables for use in Anisometric Drawing.

In this it differs from the monodimetric, where dimensions in two axial directions are measured on one and the same scale, but those in the direction of the other axis on a different one; also from the isometric, in which all dimensions in any axial direction are measured on one and the same scale, and the three axes stand at equal angles with one another.

In this system one can choose any desired relation between the lengths of the lines representing equal lengths in the three axial directions; and for each set of lengths or of proportional foreshortenings, there is a set of angles at which the axes stand to one another and to the horizontal. One of these latter axial directions is usually chosen as 90 degrees or vertical; this may have the greatest or the least amount of foreshortening or may be between these two.

A table herewith shows for several relative axial proportions the angles at which the two non-vertical axes stand to the horizontal, the amount of foreshortening that takes place along either axis (as compared with the lengths on geometrical plan and elevations) and the sines of the afore-mentioned angles.

Referring to the sketch, we will draw $ABCO$ to represent in elevation a cube, which it is proposed to draw in an anisometric projection where the relation of the axes is about 1:0.5:0.9. From the table we learn that the respective foreshortenings corresponding to the angles of this projection are for OX 0.9853, for OY 0.4927, and OZ 0.8868; and that the natural sines of the given angles $\beta = 17° 49'$ and $\alpha = 5° 11'$ are 0.3060 and 0.0903. If, then, AB is the edge of the cube which we wish to draw, and $ABCO$ the face, we lay off $AX = 0.9853$ AO; and with radius, OC, strike the arcs, CY and DZ. On AO produced we measure $Oy = 0.3060$ and $Oz = 0.0903$, and draw Yy and Zz to cut CY and DZ. Then, on OY and OZ, which are the foreshortened axes, we lay off $OE = 0.4927$ AO, and $OF = 0.8868$ AO; we can then complete the cube.



Cube Drawn by Anisometric Projection.

Hanover, Germany. ROBERT GRIMSHAW.

PUNCH AND DIE FOR MAKING SQUARE NUTS.

Editor MACHINERY:

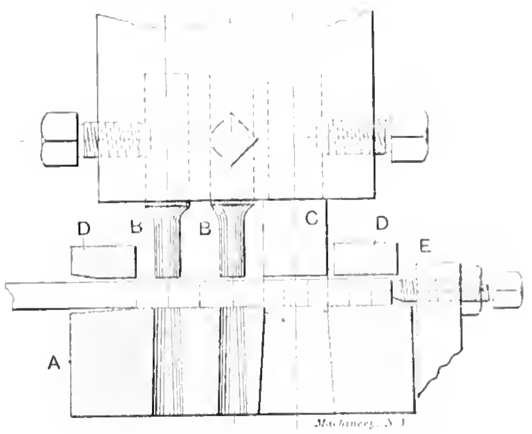
The following experiment with punch and die work may be of interest to some of your readers confronted with similar problems.

In an agricultural implement manufactory there was required about thirty tons of square nuts suitable for a ⅜-inch tap. It was thought that they could be much more economically made on the premises than they could be purchased. The iron was accordingly ordered in 16-foot bars, 5-16 x ¾ inch, and it was planned to punch the holes and cut off the pierced nut at one stroke of the press. A punching press was accordingly fitted up on this plan, but it was found to be not much of a success, for the reason that if the iron was fed in over the cutting-off die, the exact width of a nut, the latter would bend downward as the punch was forced down, and make a badly-shaped nut, or the cutting-off punch would be broken. Sometimes the piercing punches were also broken by the strain put upon them. Passing the iron in far enough to give the extreme end a bearing on the far side of the die, or making the cutting-off punch and die smaller and trimming the nut on all four sides did not seem to help matters much, and it produced considerable scrap.

After a couple of weeks experimenting with no improvement in the results, the plan was finally abandoned and some new device looked for that promised better success. The iron had been rolled with very flat edges and good corners, and as the nuts were all painted after being put in place, it was not necessary that they should be trimmed on all four sides. A new man took up the problem, and had the press fitted up with the punches and die as shown in the accompanying engraving. A is the die, pierced with two circular holes for the two piercing punches B, and a square hole ¾ x ⅞ inch for the cutting-off punch C, this hole being made wider so as not to trim the sides of the iron. Two strippers D are set very closely down

to the iron so as to confine it in place vertically, as closely as possible and still allow it to be freely pushed through by hand, while it was held laterally by pins fixed in the strippers.

In operation the bar of iron was fed in with its rough end against the stop-screw *E*, and at the first stroke of the press two nuts were pierced, one complete nut cut off, and the rough end left as waste. The first whole nut on each bar was therefore a blank and must be pierced in another press, but the balance of the bar was cut up into nuts with no waste but the piercings, and as the two nuts were cut off and pierced at each stroke of the press, the output of the machine was doubled. The nut forced against the stopscrew *E* was thrown out at one side by an ejecting lever (not shown) forced forward by a spring, and actuated by a ratchet wheel and pawl, whose carrying lever was operated by a connection with the press ram, by means of which, on its upward



Punch and Die for making Square Nuts.

movement, the lever was released, the nut ejected, and the lever set for the next stroke. A friction roll feed might probably have been added to advantage, but the operator seemed to have no need of it.

In the former plan it was found difficult to prevent scrap from collecting on the die, between the cutting-off punch and the stop-screw. By this plan no difficulty was experienced. The results of this arrangement were, that the output of the press was doubled, there was no difficulty with broken punches, and no scrap but the bits at each end of the sixteen-foot bars and the piercings. The press worked up considerably over thirty tons of stock, with no expense for repairs save grinding punches and replacing them when worn too short for further use.

OSCAR E. PERRIGO.

New Haven, Conn.

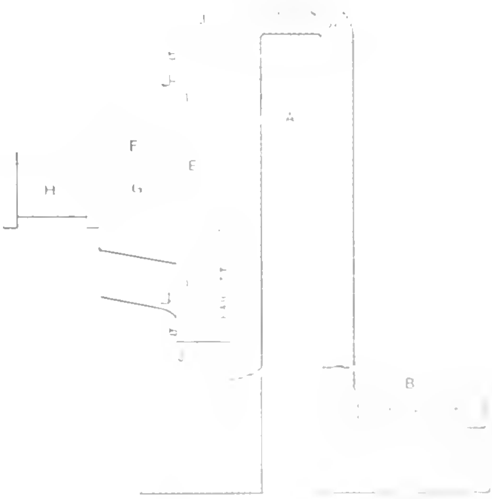
MAKING A JOINT ON ROUGH SURFACES BY THE AID OF SOFT METAL.

Editor MACHINERY:

Two rough surfaces sometimes come together in the construction of machinery because of a change in the design, hence, where no fitting pieces have been provided. Nevertheless such a joint must be strong and firmly made, and part of the attached piece must have a position in line with and parallel to some other part, say the center line of the cylinder of an engine, as once occurred with me in the erection of a number of compressor engines for compressing and pumping carbonic acid gas. Similar joints can be made to equal the best faced joints by the use of Babbitt metal or a metal composed of 8 parts of lead to 1 of antimony.

Before describing the job I may mention that the steam engines of the carbonic acid gas compressors I erected were of the double-disk crank type, with overhanging fly-wheels. The steam cylinders were attached to one side of the bed and overhanging, and measured about 16x18 inches, while the compressor cylinders were 22 inches in diameter. The pump cylinder stood on a plate bolted to a foundation distant from that of the steam engine, but connected with the steam cylinder by two bolts or rods $2\frac{1}{2}$ to 3 inches in diameter. The stuffing-boxes at either end of both cylinders were packed with metallic packing, alternate rings of gun metal and babbitt metal being fitted together with bevel joints, thus insuring the central location of the pistons, which both extended through the stuffing-boxes in the heads of the respective cylinders, preventing their dragging on the bottoms of the cylinders. For connecting the piston rods of the steam engine and the compressor, the best device was used that I ever saw, since it permitted a fine adjustment in the location of the pistons, was easily detachable for repairs and easily assembled again, and was firm and tight when put together. A V-thread was cut on the end of both piston rods, 8 threads to an inch and 5 inches long. A connecting nut 8 inches long was used, parted horizontally through the center, the joints being planed open about 3/16 inch, and assembled by four bolts provided with jam-nuts. The steam piston rod was secured to the crosshead in the same manner, a cap being parted horizontally from the shoe or bottom part which slid in the guide.

The valves of the pump or compressor were originally of the poppet type, set horizontally in the cylinder heads of the pump and worked by the gas like the valves of a pump. By their frequent breaking, however, these gave so much trouble that a slide valve was adopted, worked like the slide valve of an engine by an eccentric on the crank shaft, the eccentric-rod taking hold of a pin, *H*, in the sliding head *F* attached to the valve stem, *G*. The sliding head, of course, must move true and parallel with the center line of the valve. Since no fitting pieces had been cast on the engine bed, the slide valve being an improvement due to an afterthought, it was necessary in order to make the guide true with the face of the valve and parallel with the center line of the valve seat, to make the joint by running soft metal under the guide, that is, between the guide *E* and the engine bed *A* after the guide was located in position. The guide *E* was a flat plate $1\frac{1}{4}$ inches thick and about 10 inches wide by 12 inches long, with projections planed to receive the sliding head and its gibs. It was drilled for seven or eight stud bolts, *J*, and six $\frac{5}{8}$ tap holes were drilled for adjusting setscrews. These six setscrews, *I*, were to adjust the guide plate with its planed surface parallel with the center line of the valve stem, the vertical adjustment being made by a spirit level since the center line of the engine or axis of the cylinders was level. To locate the guide I first chalked the engine bed and held the guide in place by a light jack screw resting on a heavy saw horse weighted down by pig iron. I then placed a piece of plank, planed true against



Joint between a Guide and an Engine Bed made of Soft Metal

the edge of the guide *C* for the crosshead, and set the guide plate true by measuring from the plank to the planed edge of the guide plate with a pair of large outside calipers. After the plate was true and level, I scribed the bolt heads, removed the plate, drilled and tapped the stud bolt holes, readjusted the guide plate, stopped the opening around the edges with strips of dry pine planed true, covered the cracks by well worked clay and poured in the metal, using a pretty good riser to insure its filling the space perfectly. When the soft metal, *D*, had cooled, I took out the setscrews and screwed up the nuts as much as I could, and the guide was as firmly located as though against a planed joint.

C. E. MINK.

Syracuse, N. Y.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO PREPARE EMERY FOR FINE LAPPING.

Emery for very fine lapping work must be sifted and resifted, and I have used the alternative process here described with very good results. Place 2 pounds of flour emery in a linen cloth a foot square, tying the edges together so that no emery can escape. Sift the emery on a clean sheet of paper by easily rapping the bag on the paper so that only the finest grains will work through. Put the sifted emery into a glass with about 4 times as much good lard oil, mix well, and let stand for 10 hours. After this settling, run the fluid carefully into another glass, leaving the deposit of the heavier grains of emery behind. Repeat this two or three times, and the result will be an extra fine preparation for lapping the finest plugs, rings, etc. JOS. M. STABEL.

Rochester, N. Y.

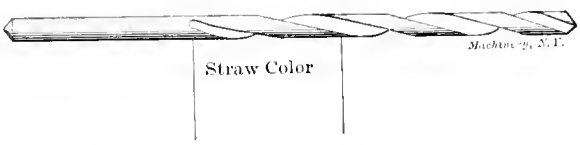
TO HARDEN THIN SAWS WITHOUT WARPING.

I have hit on a way of hardening thin saws and disks without warping, which is quite satisfactory. I use two iron blocks, dropping the hot saw upon one block and clapping the other block on top of it. I use these blocks dry and get better results than by the usual method of flooding with oil. The reason I believe to be this: When the hot saw is dropped onto the dry block or plate it cools from the outside, but the top plate being immediately dropped upon it straightens it out and chills it into a perfectly flat shape. If the lower plate is flooded with oil, however, the saw cools and sets before the upper plate can be clapped upon it, hence it comes out warped. I have hardened slitting saws up to 0.022 and 0.034 inch thick by this method and have found them tough and capable of standing rather rough treatment.

Belvidere, Ill. V. H. MARCELLUS.

TO REDUCE SMALL DRILL BREAKAGE.

Foremen having men or boys who break an excessive number of small drills, may reduce the number somewhat, if they take the advice given to me by an old English machinist. If the drill is drawn to a straw color at the section shown in the



cut, it reduces the brittleness and consequently the liability to snap off so easily. This little wrinkle may not be new to some, but it was to me, and as it has effected quite a saving in our expense for small drills, we naturally feel that others will appreciate it.

Lancaster, Pa. PARK B. SHEE.

SOLDERING ALUMINUM.

Several years ago I made some experiments on soldering aluminum, and found that aluminum could be soldered with ordinary solder (equal parts of lead and tin) and no flux at all. My successful experiments were as follows:

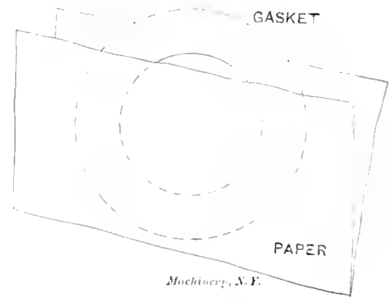
Taking a piece of sheet aluminum I would gradually heat it, at the same time rub it vigorously with a very hot soldering iron; in a short time a dirty substance would apparently work out of the metal that looked very much like the scum that comes on the surface of melted Babbitt metal. Directly after this the solder would begin to adhere to the aluminum, and it could be tinned quite nicely; after being tinned it was an easy matter to sweat or solder the pieces together.

I had heard that solder would come loose from the aluminum after a while, when soldered by the methods then in use, so I put away some of the pieces I had soldered in this manner, to observe the action of time on them, and they remained in good shape as long as I had them. I finally lost them and have never since repeated the experiment. I have since read that aluminum could be welded by careful manipulation at a temperature slightly below the melting point; if this is true it seems very reasonable that soldering by this method will be permanent. It is possible that I brought the pieces to the welding heat in tinning but this seems improbable.

Indianapolis, Ind. R. EARL WEINLAND.

CUTTING AND APPLYING GASKETS.

In cutting rubber for gaskets, etc., have a dish of water at hand and keep wetting the cutter. This method has been used on rubber packing washers 1 inch thick with excellent results. When putting a gasket in place chalk the flanges, and you will not have so much trouble in removing the gasket when the



joint is broken. Often two flanges cannot be separated any great distance and one has trouble in inserting the gasket; put it between a folded sheet of paper as indicated in the sketch and it can be placed quite easily. The paper can be torn out after some of the bolts are entered. JAMES A. PRATT.

Howard, R. I.

RIG FOR MILLING THE UNDER SIDE OF BOLT HEADS.

Having a number of screws of the type shown in Fig. 1 to mill under the heads, as indicated in Fig. 2, I devised the fixture illustrated in Figs. 3 and 4. It consists of the body *A* made of mild steel. It was planed all over, and a groove was cut through the body lengthways which was made of the same width as the diameter of the body of the screw. A hole was counterbored in the center to a depth equal to the thickness of the head after being milled. Two clamps *B* were made of steel, which were hardened to prevent bending. These were machined to fit the groove, thus keeping them from shifting sideways and always in line with the body of the screw to be milled. The two binding screws *C* were also made of steel hardened.

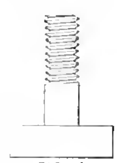


FIG. 1

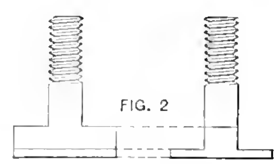


FIG. 2

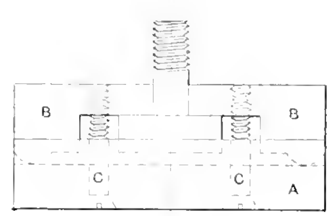


FIG. 3

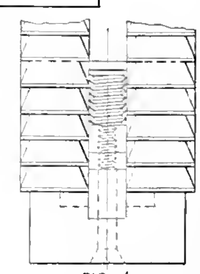


FIG. 4

A pair of 4-inch straddle mills held apart by a collar of a width equal to the diameter of the screw was used to mill the heads. After placing a screw in the fixture as shown in the cuts, Figs. 3 and 4, the fixture was placed in the vise on the milling machine, the straddle mills being set to the clamps for position sidewise, and just touching the body of the fixture for the vertical position. With the rig it was possible to mill the heads with only one cut and it was found quite satisfactory, especially as the screws had no centers and it would have been a difficult job to mill them otherwise without some special fixture. W. C. F.

SHOP RECEIPTS AND FORMULAS.

Practical Tried Receipts—those known to be Good—are Solicited.

FROSTING BRASS-WORK.

Boil the brass in caustic potash, rinse in clean water, and dip in nitric acid till all oxide is removed; then wash quickly, dry in warm boxwood sawdust, and lacquer while warm. This will give brass an ornamental finish.

Angelica, N. Y. F. H. JACKSON.

GLUE FOR LEATHER BELTS.

Take common glue and isinglass, equal parts; place them in a glue pot, cover with water, let soak 10 hours, bring to a boiling heat, add pure tannin to make to consistency of the white of an egg. Apply warm, have surfaces clean and dry; clamp joint firmly and let dry. L. E. MUNCY.

Syracuse, N. Y.

SOLUTION FOR DRILLING HARD STEEL.

A mixture which will permit hard steel or iron to be drilled with ordinary drills is made by using 1 part spirits of camphor and 4 parts turpentine. Mix well and apply cold, letting it remain a few minutes before applying the drill. Run the drill slowly with fine feed. C. E. MINK.

Syracuse, N. Y.

TO WATERPROOF GLUED JOINTS.

To render glued joints waterproof, rub common chalk on the surface of the wood where the glue is to be applied, and then coat with ordinary glue in the usual manner. The chalk will protect the glue from moisture so that the joint will hold as well after being soaked in water as before. I tested this method some time ago and found that it works very well.

Lansing, Mich. W. S. LEONARD.

PERMANENT IRON CEMENT FOR STEAM PIPES.

To make a permanent cement used for stopping leaks in steam pipes where calking or plugging is impossible, mix black oxide of manganese and raw linseed oil, using enough oil with the manganese to bring it to a thick paste; apply to the pipe or joint at leak. It is best to remove pressure from the pipe and keep it sufficiently warm to absorb the oil from the manganese. In twenty-four hours the cement will be as hard as the iron pipe. JAMES H. TAYLOR.

Oswego, N. Y.

TO BLACKEN BRASS FOR TEMPLET WORK AND OTHER PURPOSES.

The brass must be thoroughly cleaned, and then is heated slowly over a charcoal fire, care being taken not to allow the brass to touch the charcoal, or indeed not to allow any sparks from the charcoal to come in contact with the brass or it will cause red spots. As soon as the brass is slightly red, dip it into nitric acid and reheat, just short of red. Rub strongly with a stiff bristle brush and clean with a greasy cloth. This gives a fairly permanent dead black finish.

P. H. OTO.

MIXTURE FOR PLUGGING HOLES IN CAST IRON

A good mixture for plugging blowholes in cast iron is made of sulphur, cast-iron borings sifted very fine, and graphite. Melt the sulphur in an iron ladle and stir in as much of the sifted borings as the sulphur will allow, not making it too thick to pour readily. Add a small quantity of the graphite, say a tablespoonful to a quart of the mixture. Pour into the holes while hot, and after it is cool smooth off with a file. When holes are filled with this mixture on surfaces to be machined, a finishing cut can be taken over it which will obliterate the holes. R. B. CASEY.

Schenectady, N. Y.

TO KEEP MACHINERY FROM RUSTING.

A formula for an anti-rust compound is made as follows: Dissolve 1 ounce of camphor in 1 pound of melted lard; take off the scum, and mix in as much fine black lead as will give it color. Clean the machinery, and smear it with the mixture; and after 24 hours rub clean with a soft linen cloth. The machinery will keep clean, under ordinary circumstances, for a long time. JAMES A. PRATT

Howard, R. I.

NON-CORROSIVE SOLDERING FLUID.

In "How and Why" of the September, 1904, issue of MACHINERY, I notice a formula for a non-corrosive soldering fluid which is not given in what I consider the most economical form. I put any quantity of chloride of zinc in a bottle, fill it up with alcohol, and allow it to stand at least 48 hours, then carefully pour off the alcohol, mix with an equal quantity of glycerine and shake. The zinc remaining in the bottle can be used until there is nothing left of it, since the alcohol which is poured off after 48 hours contains all the chloride of zinc which is necessary for good soldering. It is not necessary to use glycerine, the office of the glycerine being merely to keep the alcohol from spreading. HERMAN JONSON.

New York.

PASTE FOR HARDENING HIGH SPEED STEEL.

The hardening paste made according to the following receipt has been used on high-speed steel with success, enabling it to be hardened by heating in an ordinary gas oven, and thus making unnecessary the very high heat usually called for in hardening such steels. Mix 2 pounds rye meal; 1 pound common salt; 1/4 pound pulverized borax; 1/4 pound pulverized charcoal, 1-3 pint (or 1/2 pound) liquid cyanide of potassium; 1/2 gill or 2 ounces of water glass (silicate of soda); and 3 pints of water. The liquid cyanide is made by dissolving 3 ounces of pulverized potassium cyanide in one pint of boiling water. Mix thoroughly to form a paste.

When using this paste I have found it best to apply it in the following manner: Provide a small cast-iron vessel or a crucible of the shape of a drip-pan, and spread a thin layer of the paste on the bottom; put the work in the pan and cover that with paste also. Place work and pan in the gas oven and heat until it reaches a nice full red. Dip in sperm, fish or kerosene oil. JOS. M. STABEL.

Rochester, N. Y.

SOLDERING ACID AND SOLDERS

I have seen a number of different formulas for soldering acids and have had occasion to try several of them with more or less satisfaction. Among all the different ones which I have tried, I know of but one, however, that actually can be said to fill all requirements. As the formula for this acid is not generally known it may be valuable to the readers of MACHINERY to add same to their collection. The acid is composed of: Solution chloride zinc, 1 ounce; glycerine, 1 ounce, alcohol 7 ounces.

As far as the solder itself is concerned, one can, of course, make compositions of tin and lead in almost any proportions to fill the requirements in general. The melting point of these different compositions will vary greatly, however, according to the proportions of above metals in same, and, of course this is an important factor in many instances, especially when wanting to solder metals which have a low melting temperature in which case the solder ought to be a composition which itself will melt at a very low temperature. If bismuth is added to the composition the melting temperature will almost invariably be lowered. I have on hand a fairly complete table of compositions for solder giving their respective melting temperatures and the metals for which they are best adapted.

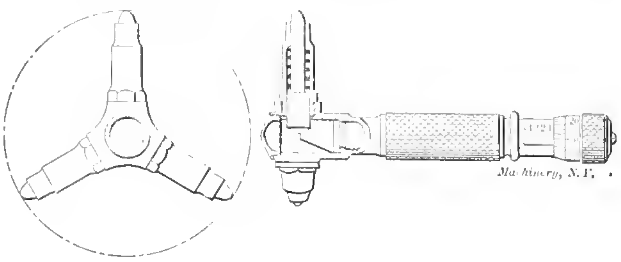
Tin.	Lead.	Bismuth.	Melting Point Deg. F.
15.5	32.0	52.5	205
20.0	26.0	54.0	214
20.6	26.8	52.6	217
21.4	27.8	50.8	225
24.8	22.1	53.1	237
20.0	20.0	60.0	250
15.0	25.0	60.0	257
63.2	36.8		361
60.0	40.0		372
70.0	30.0		381
50.0	50.0		415
34.0	66.0		446
30.0	70.0		495

A.

ITEMS OF MECHANICAL INTEREST.

NOTES OF A VARIED CHARACTER GATHERED FROM DIFFERENT SOURCES.

We illustrate herewith a precision gage taken from the *Portefeuille Economique des Machines* for February, for measuring exactly the diameter of a drilled hole. This, as may be seen, is a modification of the well-known star gage, used for getting the inside diameter of rings, etc., in gun work. It is composed of three radially-disposed stems, which are moved outward together by a cone, placed on the end of a micrometer screw carrying a vernier, by which readings to hundredths of a millimeter may be obtained. These stems are kept in engagement with the cone by spiral springs. The three points can be replaced by sets of longer points for measuring the diameters of larger holes. With these sets of points and two instruments, one of 12 millimeters and the other of 27 millimeters movement, it is stated that the greater number of drilled holes met with in practice can be measured. This gage has the advantage as compared with the ordinary inside micrometer gage, that the roundness of the hole as well as its diameter can be accurately determined.



SAFETY LATHE DOG.

A safety lathe dog intended to prevent machinists' clothes catching therein is illustrated in the accompanying cuts. Mr. Robert Grimshaw, Hanover, Germany, says, although the idea is covered in Germany by a design patent, it is not patentable in any country. It is made in Germany by Albert Koch & Co., Neuss a. Rh. As will be seen from the illustrations, the idea is simply surrounding the ordinary lathe dog by a rim attached to same by arms, making the contour of the dog that of a pulley or wheel. A possible advantage of this design, aside from the safety feature, is that it is more nearly balanced than the ordinary type, hence would not have as great a disturbing effect due to want of balance when running at high speed.

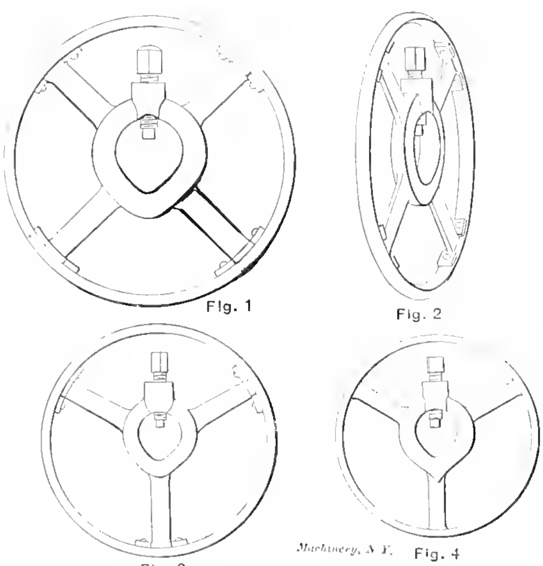
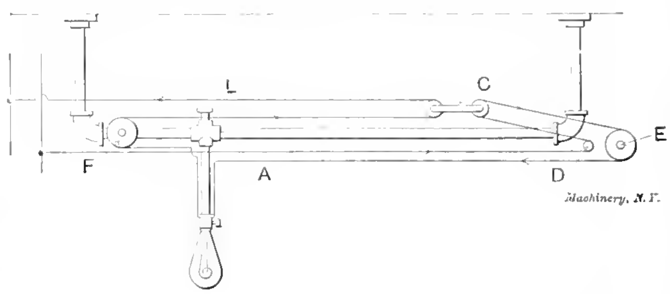


Fig. 1 Fig. 2 Fig. 3 Fig. 4

PORTABLE LAMP SUSPENSION WITHOUT LOOSE WIRES.

A correspondent of the *Western Electrician* describes a method of suspending an electric lamp over a work bench or lathe by which it may be shifted from one end to the other without having loose wires as is necessary with the ordinary flexible connections. These are always a source of annoyance and are sometimes dangerous for one never knows when such connections may become abraded or cut so as to cause a short circuit.

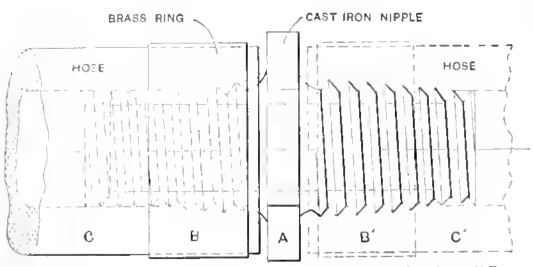
The frame is made of 1/4 or 3/8-inch pipe attached to the ceiling by floor plates. *A* is a pipe-cross drilled out so it will slide upon the pipe, with a thumb screw *L* threaded through a pipe plug and used to fasten the lamp up out of the way when not in use and also to fasten it at any angle when in use. The



arrows indicate the direction of the current in the lamp cord. Two movable pulleys linked together are shown at *C*. *D* is a porcelain knob to which the lamp cord is tied and *E* and *F* are fixed pulleys. The lamp and movable pulleys *C* move in opposite directions. As one cord lengthens the other shortens, and vice versa. The illustration is obviously diagrammatic and lacking in details, but the principle involved is clear. The supports for *D* and *E* should be upon the pipe frame itself and their connections to *C* should be in a horizontal line instead of being inclined as shown in the cut.

HOSE COUPLING.

The simple hose coupling shown in the cut is the design of Mr. W. B. Ward, of Richmond, Ind. It consists of a cast-iron nipple, *A*, having a narrow hexagon nut in the center, and two brass rings, *B*. The threads of the nipple are tapered and are cast in sharp V-form which cut their own thread in the interior of the hose as the nipple is screwed in. The feature of novelty, however, is in the application of the brass rings or bands, *B*, which are slipped upon the ends of the hose before the nipple

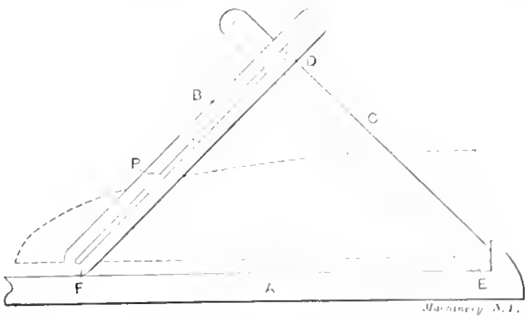


is screwed in. The bands hold the hose firmly so that it cannot expand over the threads and leak or slip off. While the invention was designed for connecting garden hose and has been used for that purpose only, we believe, this use does not seem to us to be its limitation, for the idea could doubtless be profitably used for securing hose fittings generally, especially air-brake hose, which as every one knows who is familiar with the subject, are rather awkwardly connected now,

SIMPLE DEVICE FOR DRAWING ELLIPTIC CURVES.

A correspondent of the *English Mechanic* describes a simple device for drawing elliptic curves which is not without interest and value. It has the merit of being quickly adjusted for any required major or minor axes within the limits of the instrument, but has the defect that only one-quarter of the ellipse can be drawn at one setting. *A* is a straightedge with a stop or projection at *E*. *B* and *C* are slotted rods, each having the lower ends truly rounded to perfect semi-circles for the obvious reason that any other shape would distort the shape of the curve. The rods are held together by a joint similar to that used in proportional compasses, that is, the joint may be fixed on the bars in any required proportion, and still allow them to swing on the joint as a pivot. At *P* is the holder for the pencil or scriber, and this also is adjustable in the slot. When

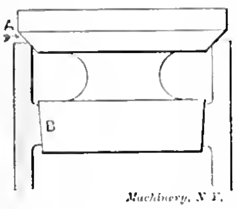
drawing an ellipse, the distance FP is made equal to one-half the desired minor axis, and PD must be made one-half the distance between the major and minor axes. The diagram shows clearly how the curve is drawn, and it will be noted that



a short section of the quarter ellipse must be drawn in free hand, since the pencil at P will interfere with the bar C when nearing the vertical position.

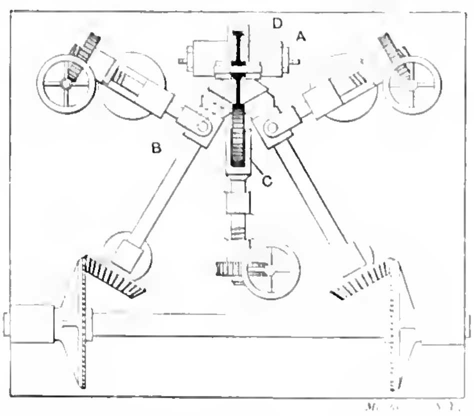
VALVE DISK DESIGN TO PREVENT CUTTING.

The greatest deteriorating influence to which the disk of stop valves is subjected, is the cutting action of the steam when the valve is being opened and closed. The high velocity of the steam passing through the constricted opening causes it to act very much like a sand blast, with the result that the seating surfaces are quickly scored and grooved, especially with high-pressure steam, making them leaky. A variety of schemes has been proposed for correcting this evil, and the one shown in the accompanying cut has been used in several shapes with more or less success. This particular device is used by Holden & Brooke, West Gorton, Manchester, England. The valve disk is extended downward so as to form a conical point B having a slight taper. When the disk is closed the piston B shuts off the flow of steam almost entirely before the disk seats at A. Hence the cutting or scoring effect is greatly reduced. It is claimed that valves with this design open and shut more easily than those of the ordinary plain disk type, and that they work very successfully under severe conditions.



TO MAKE GEAR WHEELS BY A ROLLING PROCESS.

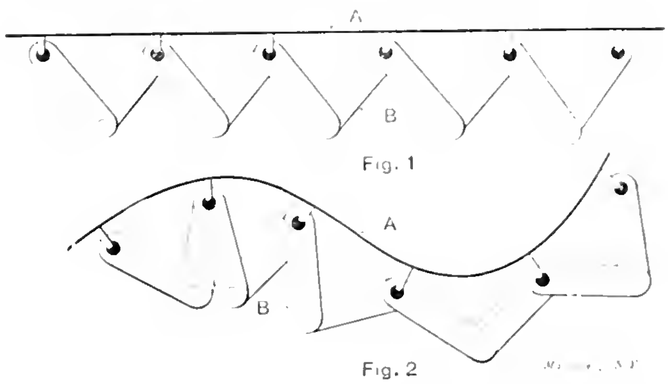
A British patent has been granted for a process of manufacturing gear wheels by rolling. The machine for doing the work is shown diagrammatically in plan view in the accompanying sketch. The block from which the gear wheel is to be made is first heated to forging temperature and shaped to a rough blank in a drop press. It is then mounted as shown at D and pressed into shape by the rollers B, while the hardened gear wheel C imprints the teeth upon its periphery. The



rollers and gear wheel are fed to their work by the hand wheels shown. The rolling process is very similar to that employed in the making of rolled steel car wheels, the face roller in this case being replaced by the toothed wheel C. While such a process may be possible and yield good results, it seems scarcely practicable save for some certain types of gears which are made in large quantities to standard dimensions, as, for instance, spur gears for street railway motors, etc.

FLEXIBLE CURVES FOR DRAFTSMEN.

We have received from W. J. Brooks, 33 Fitzroy Street, W. London, samples of the Brooks' flexible curves for draftsmen two of which are illustrated herewith, Figs. 1, 2 and 3. Both of these styles are self-clamping, that is, when the curve has been adjusted it holds its shape. In Fig. 1 the construction is a flexible steel strip A to which are attached at intervals of about $1\frac{1}{2}$ inches, the jointed pieces B. When the steel strip A is bent to a curve, the angular positions of the jointed bars are changed, and the friction of their joints holds the curve, as illustrated in Fig. 2. The construction of Fig. 3 is better adapted to long curves. The steel strip A is con-



Figs 1 and 2. Brooks' Flexible Curve

nected to light wooden strips B about 6 inches long which slide through clips D on the traverse wooden bar, C. The friction of these clips is sufficient to hold the strips in whatever position they may be set, and thus the shape of the curve is maintained. Both styles of curves can be reversed, that is, used either side up, which makes them convenient for symmetrical drawings. The third sample curve sent is made of transparent celluloid to which are attached celluloid finger-pads with which the shape of the curve is held with one hand while it is traced with the other. The fourth curve is made of steel on the same principle, hence, weights are depended upon to hold it in position while tracing a curve.

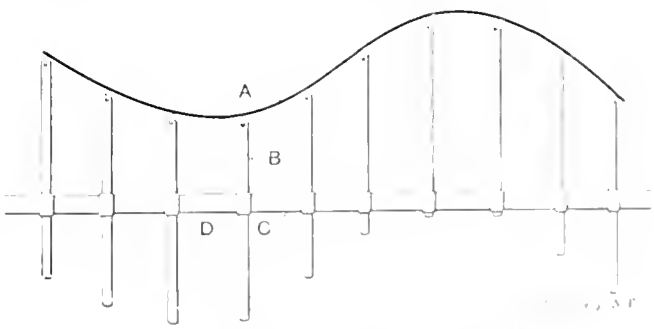


Fig 3. Another Form of Curve for Draftsmen

Accompanying the curves was a sample of the Brooks' parabola curve which is made very accurately from transparent celluloid by specially designed apparatus, and has its axis focus, and latus rectum engraved upon it. While designed for the study of the parabola and to assist teachers of mathematics in the solving and demonstration of certain problems by the use of squared paper, it is quite useful as a set curve for draftsmen, and will be found a convenient addition to the drawing board. The axis line being drawn very accurately at right angles to the latus rectum, makes it a convenient means of drawing lines at right angles.

* * *

A fan capable of handling 3,000 cubic feet of air per minute and a special form of heater designed to heat as a minimum 2,000 cubic feet of air per minute from 32 degrees to 200 degrees F., or a proportionately larger amount from a higher natural temperature, were recently furnished the Bureau of Engraving and Printing at Washington by the B. F. Sturtevant Co. It was stipulated that the coils should be so completely enclosed with thicknesses of asbestos, and so thoroughly insulated, as not to transmit heat to the room in which they were placed, which difficult conditions appear to have been met with success.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

40. P. M.—Can any of the readers of MACHINERY give me a formula for figuring the square inches of surface required on expansion ring frictions per horse-power, per each 100 revolutions?

41. J. S. W.—I need a grease or oil that will not freeze at, say, 40 degrees below zero, to use in a ball bearing. It need not be a good lubricant, as its principal purpose is merely to keep the balls from rusting. I think vaseline would probably do but cannot find out what its freezing point is. Can you tell me the most suitable grease for this purpose?

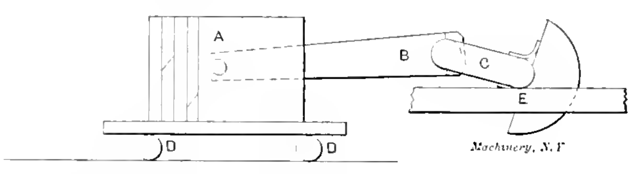
42. H. F. S.—Please state in "How and Why" how leather can be crimped like the enclosed cup leather, without spoiling its appearance. We have the dies and by wetting the leather are able to form it perfectly, but this blackens and roughens the surface of the leather. Dry, it will not crimp at all. What material can I use to coat the inner surface of the die to prevent rusting while in use—one that will not rust the leather? We submit this to our readers.

43. C. H. R.—What shrinkage allowance is generally made in drop-forging dies for copper?

A. We are informed that the practice of J. H. Williams & Co. is to make a general shrinkage allowance of 3-16 inch to the foot in drop-forging dies for copper.

44. J. V.—In balancing a high-speed gasoline engine, is it correct to balance one-half the weight of the connecting rod only; if so would it be right to balance the parts as illustrated in the cut, adding counterweight until the part of the connecting-rod supported by the crank-pin is balanced? The crank-shaft is supported on level ways and the piston rests on rollers also supported on level ways.

A. Practice differs. Some builders of gasoline engines balance the rotating parts only, which, of course, includes the crank and that part of the connecting rod which is regarded as rotating weight, only; and some balance one-half the reciprocating weight additional, that is, one-half the piston weight + remainder of connecting-rod weight. The method you illustrate should work all right to secure rotative balance effect only, if due care is taken to secure the greatest possible flexibility of

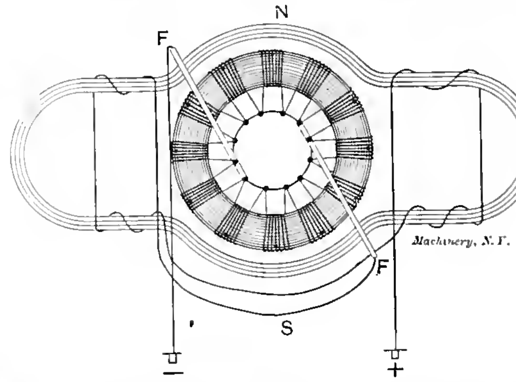


movement and to have the supporting surfaces level. A further refinement, which might be advisable with small engines, would be to test the condition of balance with a delicate spring scale. Thus, when you have added counterbalance so that crank *C* and connecting-rod *B* remain at rest when connected in a straight line, attach the spring scale to the crank-pin and note the upward pull that is required to start the linkage from a condition of rest; replace crank and connecting-rod in a straight line and then test the downward pull. When the pulls in both directions are the same you have taken into account the friction of rollers *D*, that of the connecting-rod bearings, and the negative effect of the rolling resistance of the crankshaft on *E*, hence the rotating effect should be balanced. But, whichever method is adopted, there will always be a want of balance in some direction since both the vertical and horizontal forces cannot be balanced at once in a simple engine. Moreover it is of importance, in a variable-speed engine, to make the center of gravity of the counterweight the same radial distance from the crank-shaft as the crank-pin; otherwise its effect with changes of speed does not increase or decrease proportionately with that of the crank-pin and parts connected thereto. The best way is to avoid the use of counterweights entirely and to have duplicate parts moving in opposite direction, hence the double and quadruple cylinder engines as used on automobiles, launches, etc. But even with this construction short connecting-rods have a serious disturbing influence at high speeds, and it is important that they be made as long as possible.

45. G. J. S.—In drilling holes, say 1¼ to 3 inches diameter, which is considered the best practice: to drill a small hole first in order to reduce the pressure on the point of the large drill, or to drill from the solid with the large drill alone?

A.—It is largely a matter of machine tool equipment; with the usual tool equipment found in machine shops it is unquestionably the best practice when drilling holes as large as three inches diameter, to drill a small hole first, especially in steel. The removal of the metal represented by the small hole (which is quickly made) greatly reduces the pressure on the drill-arm when using the large drill, and thus makes it feasible to use a much heavier feed than would otherwise be possible. In fact it probably would be impracticable with the great majority of drilling machines to drill a 3-inch hole from the solid as the necessary pressure would be disastrous. But if a drilling machine has been designed to stand the pressure of a 3-inch drill with heavy feed there should be little gain in drilling a small hole first. For the larger sizes of holes it is, of course, the general practice to drill, say a 2-inch hole first, and then enlarge with counterbores, but just where one practice supersedes the other is largely determined by the power and rigidity of the machine.

46. Novice.—I send sketch of a small motor I made—length of field magnet inside, 10½ inches; internal diameter of polar section 3⅝ inches; number of layers of wire to each coil, 5; number of convolutions in each layer, 34; size of wire



A. M. W. G. No. 16; number of coils on armature, 12; number of layers on each coil, 4; number of convolutions in each layer, 8; size of wire on armature A. M. W. G., No. 18. The machine runs all right as a motor but will not generate any current as a dynamo. I have run it at as high a speed as 2,500 revolutions per minute. Have changed the brushes, in fact, have done all that I can think of, but to no purpose. Can you enlighten me?

Answered by Wm. Baxter, Jr.

A.—Small motors will not run as generators as a rule. The reason why they will not run is, that the distance between the iron of the armature core and the faces of the poles *N S* is too great to permit the machine to build up the field magnetism. When a generator starts, the residual magnetism left in the field cores is sufficient to develop an electro-motive force in the armature great enough to start a current that is strong enough to increase the magnetism of the field. In this way the action gets a start, the small current generated in the armature increases the strength of the field magnetism, and this in turn increases the current generated by the armature. Thus the armature helps the field, and the field helps the armature. When a machine is very small, however, the distance between the iron of the armature and the pole faces is much greater in proportion than in a large field, the number of turns of wire on the field and armature is smaller in proportion, the resistance of the wire is greater in proportion and the residual magnetism is not so strong. All these differences put together prevent the small machine from generating. If the armature of the small machine is rotated at a high enough velocity it will generate, but this velocity might be greater than it would stand. If the poles are bored out true, and an armature is used with grooves to wind the coils in, so that the tops of the teeth will not be more than two hundredths of an inch from the pole faces, the machine will generate.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

THIRTY-INCH VERTICAL BORING MILL.

A vertical boring and turning mill recently brought out by the Colburn Machine Tool Co., Franklin, Pa., is illustrated in front and back views in the accompanying figures. The mill will take in work 18 inches high, and has a swing of 30 inches. It has 16 changes of speed in geometrical progression varying from 3.2 to 106.2 revolutions per minute.

Colburn Thirty-Inch Vertical Mill.

The drive is from a spur pinion to the main driving gear bolted to the lower part of the table. The table spindle extends downward nearly to the floor, and has two large vertical bearings to resist side strains, as well as a large phosphor bronze conical bearing at the top, all these bearings being well lubricated. The back gears may be thrown in and out without stopping the machine by means of the handle shown at the side of the base. There are eight feeds driven by a wide belt running on feed cone pulleys of large diameter. The feeds are reversed by means of the hand lever shown directly above the upper feed cone pulley.

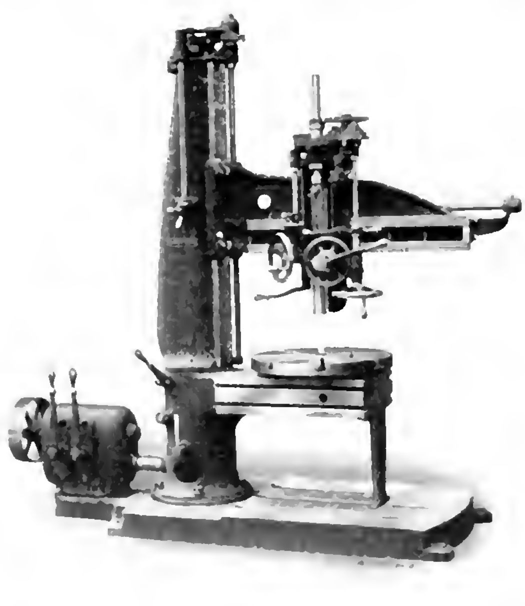
The vertical slide has a travel of 23 inches either by hand or power. Attached to the turret slide is a graduated scale 24 inches long, over which an adjustable pointer moves, indicating the travel of the turret slide. The cross slide has a travel of 17½ inches by hand or power, and is equipped with an automatic stop for tripping the feed before the head comes to the center stop. The turret is 10¼ inches in diameter, and has five holes bored to fit tool shanks 2¼ inches in diameter. The turret has a clamp lever which remains in a vertical position when relieved, as shown in Fig. 1. The lock bolt is of hardened tool steel, and works in a hardened tool steel index ring, bolt and ring both being accurately ground.

The mill can be furnished with a plain table, with or without chuck jaws, or with a 3- or 4-jaw combination, independent and universal chuck. A double friction countershaft is furnished, having two pulleys 14 and 20 inches in diameter for a 4-inch belt. Both pulleys run in the same direction, one at 150 and the other at 375 revolutions per minute. The weight of the mill is 4,500 pounds.

THREE-FOOT COMBINATION RADIAL DRILL.

The illustration shows a radial drill with 3-foot arm built by the American Tool Works Co., Cincinnati, O., which is preferably driven through a speed box, although a cone pulley drive may be used. The drill is built for the use of high speed steels; the column is of box girder type, revolves in a stationary stump carrying conical rollers, and is clamped securely in any position by means of the lever near the foot. It is capable of being swung in a complete circle unless arrested by the belt, if driven from overhead. The arm is of parabolic beam section, and its lower line is parallel with the base, thus permitting work to be operated upon close to the column. The arm is clamped to the column by binder levers, and is raised and lowered by the double-thread coarse-pitch screw hung on ball bearings and controlled by a convenient lever.

The speed box is of the geared friction type, providing four changes of speed, available by the use of the two levers shown. Frictions are of a patented double band type, and are made of large proportions. Four feeds ranging in geometrical progression from 0.007 inch to 0.041 inch are provided by the feeding mechanism on the head, the feeds being obtained by the turning of a dial on the feed box until the desired feed indexed thereon comes under the fixed pointer. Feeds can be automatically tripped at any position of the spindle by an adjustable trip dog acting on the worm clutch. Depth graduations are marked on the spindle, and all depths can be read from zero. The spindle has eight changes of speed ranging in geometrical progression from 13 to 300, any one of which may be thrown in without stopping the machine. The spindle is regularly bored for a No. 4 Morse taper hole. The spindle is counterbalanced and has a quick advance and return by means of the lever shown directly in front. The head is traversed along the arm through a spiral pinion and rack by means of a hand wheel located on the head to the left. The back gears are located on the head and they may be thrown in or out while the machine is running. The tapping mechanism is carried on the head between the back gears and the speed box, thus giving to the frictions the benefit of the back gear ratio, making possible heavy tapping operations and permitting taps to be backed out at an increased speed. The lever for starting, stopping or reversing the spindle is, as shown, under the hand wheel for moving the head along the arm, and controlled from the front of the machine. The greatest distance from the spindle to the base is 4 feet 1½ inches; the traverse of the



American Radial Drill.

spindle is 11 inches, and that of the head on the arm is 2 feet, 3⅛ inches.

The plain table regularly supplied with this machine has a top surface of 16x26 inches, and also side surfaces, both top and side surfaces being supplied with T-slots. A worm swivelling table which can be revolved to any angle horizontally through a worm and worm wheels can be supplied. It is graduated at the point of swivelling contact. The top surface is 16x24 inches. A round table may also be supplied 24 inches in diameter, and may be fitted to either the plain or worm swivel table. It revolves by hand on a stump fitted into the other table and can be locked by a binding screw. The regular equipment of the drill consists of the machine with a cone pulley drive, plain table only, and one countershaft.

STARTING AND REGULATING RHEOSTATS FOR MACHINE TOOL DRIVES.

The accompanying cuts show a type of controller manufactured by the Cutler-Hammer Mfg. Co., of Milwaukee, Wis., and intended for the operation of machine tools or similar apparatus in which the operator is within reach of the controlling handle, the speed regulation being entirely effected by a shunt field control. In designing this controller the chief objects sought were the elimination of the possibility of the motor starting under a weakened field, the provision of a large num-

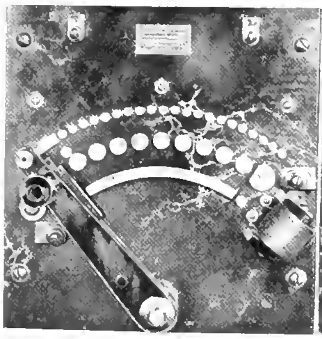


Fig. 1. Controller with Underload Release.

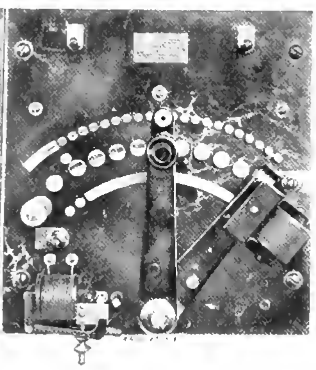


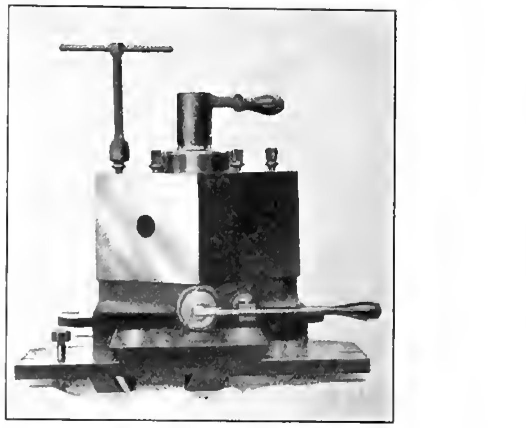
Fig. 2. With Overload and Underload Release.

ber of field regulating points, the operation of the device with a single lever, and the returning of all parts to the "off" position in case of the cessation of current or the flow of abnormal current.

The apparatus consists of a motor starter of standard construction, and a series of field buttons controlled by a field resistance lever mounted on the same hub post as the starter lever, and co-operating with the field starter lever. The motor is started and brought to speed, in operation, by moving the handle to the right, this handle being attached to the field regulator lever, which is mechanically connected to the starter lever so as to move them as one piece in starting the motor. During this operation of starting the field resistance is short-circuited by an auxiliary contact mounted on the starter lever, and a curved sector placed just below the armature contact. When the two levers have been moved to the position in which all resistance is cut out of the armature circuit, a keeper on the starter lever is attracted by the magnet, and the starter lever is held in this position. At this time also the auxiliary contact above referred to has left the curved sector, thus removing the short-circuit from the field resistance. The field lever is now free for movement over the field rheostat buttons, and may be left at any desired point, thus regulating the speed of the motor as desired. If the retaining magnet is de-energized either by failure of voltage, or by operation of the overload releasing device, the starter lever is released and returned to the starting position, carrying with it the field rheostat lever.

NEW LATHE CARRIAGE TURRET.

The Lodge & Shipley Machine Tool Co., Cincinnati, O., have brought out a new turret for a lathe carriage, which is here illustrated in place on the carriage. This turret was designed with the view of having rigidity commensurate with the increase of cutting power of tool steel, and yet being interchangeable with the regular compound rest. The chief departure from the ordinary standard in its construction is in the plate on which the cross slide moves. This plate is made to slide on the regular carriage dove tail, and be held in place by four bolts in the T-slots of the carriage wings. The cross slide is made with a bearing about twice as wide as the regular

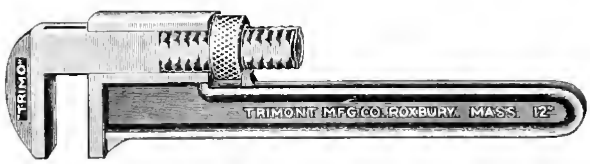


Lodge & Shipley Turret.

compound rest. The plate is slotted, permitting a cross feed nut to extend up and to attach to the cross slide so that the cross feed can be applied to the turret. The regular carriage dove tail is largely relieved of wear, since no movement of the plate takes place.

THE TRIMO MONKEY WRENCH.

The wrench here shown contains but three parts, all of which are of case-hardened, drop-forged steel. The threads of the jaw and also of the nut are rounded after the fashion of the Whitworth thread, which largely prevents the possibility of bruising them or stripping them off. The leverage of this wrench is increased in proportion to the size of the nut it is

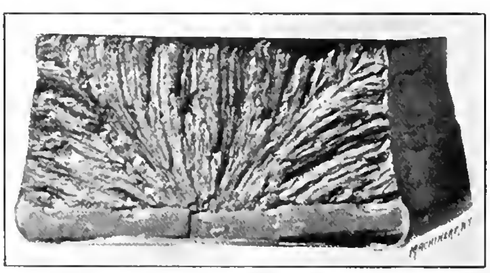


The Trimo Monkey Wrench.

used upon, as the jaw is extended forward to engage the nut, instead of being drawn back as is the case with many monkey wrenches. Three sizes of the wrench are ready for the market, the 10, 12 and 15 inch. The wrench is constructed for strength and service, and should stand considerable strain in shop use. It is made by the Trimont Mfg. Co., Roxbury, Mass.

NEW ANTI-FRICTION METAL.

A new anti-friction metal has been placed on the market by the Buda Foundry & Machine Co. of Chicago. This metal is an alloy of tin and aluminum, and has as its chief characteristic a peculiar crystalline structure which is shown clearly in the engraving. A bar of the metal was nicked and broken,



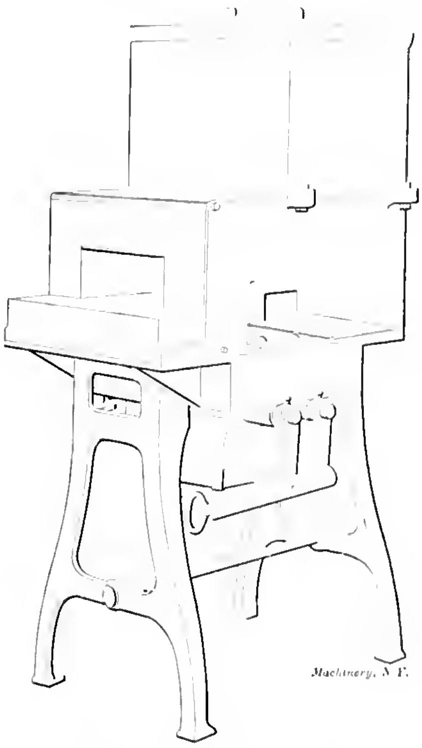
A New Anti-friction Metal.

revealing a fibrous formation with the fibers radiating from the surfaces of the bar. This feature is held by the manufacturers to be of great importance because they believe to have demonstrated that a metal of this formation will stand a greater crushing load and will be more durable under wear than if the fibers ran parallel with the surfaces, or if crystals

of the more usual type were formed in the process of cooling. To illustrate the point attention is called to the fact that the end fiber of wood forms a satisfactory wearing surface for bearings, band brakes and other purposes, whereas if the wear came on the sides of the fibers the wood would splinter and be less durable. Other characteristics of the metal are that it may be repeatedly reheated without deteriorating and that it will stand the most severe shocks without becoming brittle.

THE GANTT FURNACE.

The Gantt furnace, which was designed primarily for forging and treating high grade tool steel, is manufactured by A. P. Witteman & Co., 233-237 Cherry Street, Philadelphia, Pa. It is illustrated in one of the sizes made, in the accompanying cut. For the work for which this furnace was designed it must be maintained continuously at a constant temperature,



Furnace for Treating Tool Steel.

and the steels must be heated without oxidizing. These results are accomplished in practice with the expenditure of but a small amount of fuel, the furnace rapidly being heated up to the proper degree and the temperature being readily controlled by means of regulation of the amount of blast.

In operation, the reservoir at the top of the furnace is filled with coke or coal, which feeds the fire automatically, once the latter is started on the grate in the ordinary manner. The steel to be heated is placed in the opening in front, or in the case of the modern high speed steel where high heat is needed, in the hole in the side. The flames from the grate pass over the steel toward the front, the gases escaping through the front opening. By this method of enclosing the flame, and also in part on account of the preheating of the fuel in the reservoir, directly over the fire, the gases of combustion are fully burnt and the possibility of oxidizing the steel greatly reduced. The blast enters on the side of the furnace opposite to that shown in the cut. The blast may be easily regulated, thus maintaining a constant temperature. The fire is shaken down by means of the hand lever shown, two, or three, grates being employed. The openings of the heating chamber may be closed with fire brick when it is desired.

These furnaces are built in three standard sizes, having heating chambers of the following cross sections, size A, $9 \times 2\frac{1}{2}$ in.; size B, 14x5 in.; size C, 24x5 inches. A is used for forging, hardening and treating lathe and planer tools; it is suitable for a shop in which the amount of this work is small, and where it is not desired to run the furnace continuously. B is used for tool forging and similar high grade work when the amount is sufficient to keep one or two smiths continuously busy. This is the size shown in the illustration. By means of the small hole in the side two men may use the furnace at the same time. For small drop forgings a soft heat may be given to enough $\frac{3}{4}$-inch stock to make eight 10-inch forgings per minute all day long. As a rivet furnace it will heat without burning six $\frac{1}{2}$-inch rivets each minute, or four $\frac{5}{8}$-inch rivets, or three $\frac{3}{4}$-inch rivets. C is primarily a drop forge furnace and will heat $1\frac{1}{4}$-inch stock fast enough for six 10-inch heats per minute all day long, or four $1\frac{1}{8}$-inch rivets per minute continuously. These furnaces may be used for a number of other purposes, among which may be mentioned that of welding.

The economy of the Gantt furnace is notable, and compares favorably with that of oil as a fuel; it is said that it can be operated with less than one half the fuel needed by most coal or coke fired furnaces. Once the reservoir is filled with coal and the draught properly regulated, no further attention need be given to the condition of the fire. No connection with flue or chimney is necessary.

ELECTRICALLY DRIVEN SAND MIXER.

The Sellers Sand Mixer here illustrated is employed in mixing foundry sands, etc. It consists of a rapidly revolving table having on its top surface a number of prongs projecting upwards. The sand is fed into the hopper in the top of the machine, from which it falls upon the revolving table and is thrown by centrifugal force from prong to prong and out against the inside of the cover or hood. It emerges from beneath the hood in a fine shower, thoroughly mixed. The ma-

Sellers Foundry Sand Mixer

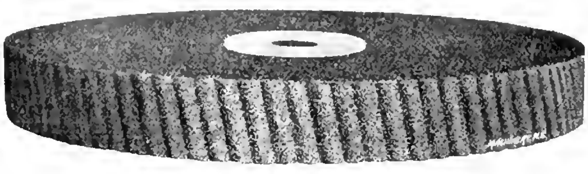
chine has a capacity of five tons per hour, which is said to be as fast as the sand can be shoveled in and taken away by two men. The mixer, which is constructed by William Sellers & Co., Philadelphia, Pa., is equipped with a Northern Variable Speed Motor built by the Northern Electrical Mfg. Co., Madison, Wis. This is a 5 H. P. motor, and operates at from 1,200 to 1,500 R. P. M. The motor equipment includes a special lubricating device. It operates from any ordinary two-wire single voltage system.

THE CORRUGATED GRINDING WHEEL.

A brief notice of a new grinding wheel manufactured by the Corrugated Grinding Wheel Co., of 5036 Hazel Avenue, Philadelphia, Pa., appeared in MACHINERY for April. This grinding wheel is illustrated herewith. The wheels have slanting corrugations or teeth on the periphery of the wheel, thus making the action that of shearing rather than grinding, which greatly increases their capacity for work. By the employment of the corrugations a second advantage is gained, that, since the corrugations are said to improve the results without regard to the hardness of the wheel, an extremely hard wheel may be used. The safety of the wheel is thereby increased. The corruga-

tions are quickly produced by a patented hand tool which requires no fixture nor previous skill of manipulation, nor removal of the wheel. The tool is passed back and forth across the face of the wheel when running.

Comparative tests have shown the advantages derived from the corrugations to be considerable. These tools have been used to grind many different materials, with results which show that the corrugated wheels grind more rapidly, with less heating and with a much less tendency to glaze, than where

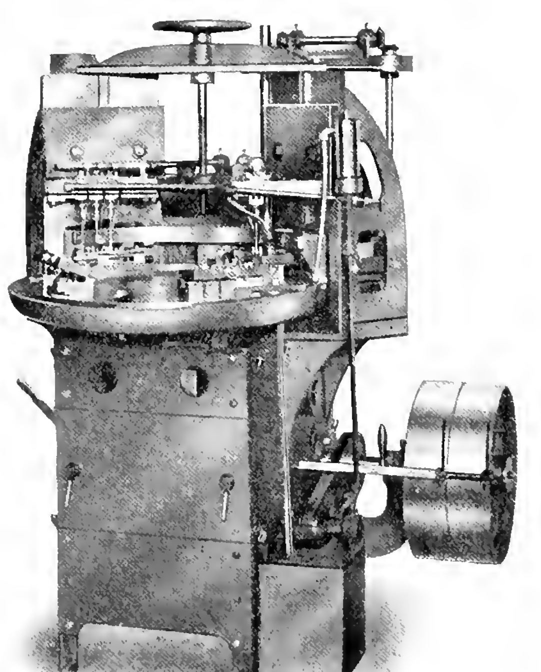


Grinding Wheel with Corrugated Face.

wheels of the same material, but without corrugations, have been used. Fifty tests were made by the manufacturers on a specially designed testing rig, by which a plain grinding wheel and a corrugated one were set to work grinding gray iron plate three-fourths of an inch thick, under identical conditions. The average of these tests showed that in thirty minutes the corrugated ground to a depth of 3 inches, while the wheel when not corrugated ground only to a depth of 1¼ inches, showing a net gain of 140 per cent. for the wheel after corrugation.

AUTOMATIC DRILLING MACHINE.

In the accompanying illustration is shown a new automatic drill of unusually large capacity that has recently been constructed by the National Automatic Tool Co., Dayton, Ohio. The machine is designed with two uprights, each carrying a head with a group of spindles. The work is placed on the rotating table which feeds upward against the drill spindles. The advantage of the two uprights is that holes may be drilled near together in the same piece, those coming adjacent being

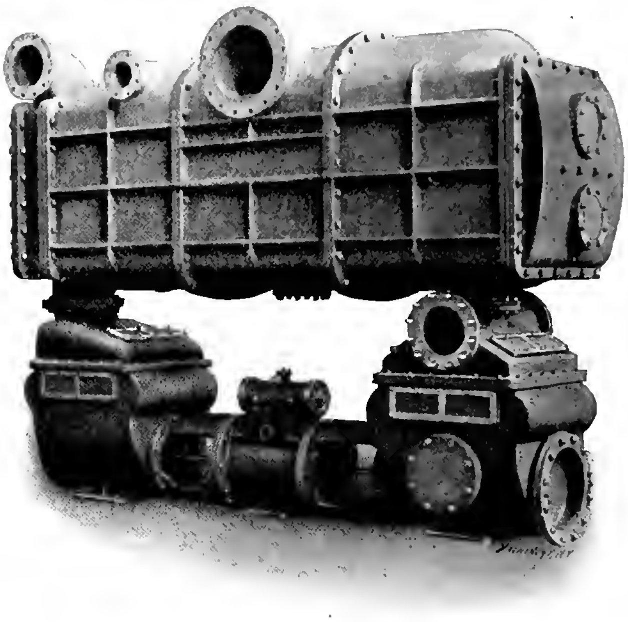


Automatic Drill for Small Work.

drilled by different heads so there is no interference of the spindles, as would be the case if it were attempted to drill all the holes with one set of spindles. The machine is entirely automatic, the operator merely placing the work in the jigs on the table and removing it when it is completed. This size of machine will drill holes from ¾-inch down to the size corresponding to No. 72 drill. A machine of this type has drilled 90,000 holes in ten hours. The particular machine illustrated was fitted to turn out 5,500 typewriter type bars in ten hours, three holes being drilled in each bar.

THE W. H. BLAKE CONDENSER.

The W. H. Blake Steam Pump Co., Hyde Park, Mass., have started manufacturing independent jet and surface condensers, one of the latter type, intended for marine work, being illustrated herewith. The tubes are of Muntz metal, so held in the tube sheets as to allow for free expansion. The steam passes in at the top and thence across the water tubes, and finally escapes below as water of condensation, rapid conden-



W. H. Blake Surface Condenser.

sation being aided by the introduction of baffle plates. The rectangular condenser shell is supported by the combined air and circulating pump, which is substantially made. The valve mechanism of the pump is actuated entirely by direct boiler pressure, so that the valves are therefore directly controlled at all points in the stroke. These pumps are composition fitted throughout, both the water and the air cylinders are lined, and a Tobin bronze piston rod is used.

FRESH FROM THE PRESS.

Mr. Alexander C. Humphreys, Consulting Engineer and President of Stevens Institute of Technology, has introduced at the Institute a course of lectures upon what he terms business engineering. He contends that the successful mechanical engineer must have an appreciation of the commercial side of engineering and is attempting to give his students a knowledge of the fundamentals of business practice as well as of engineering practice. He has issued lecture notes on some of the business features of engineering practice which we presume are intended for his students, but are none the less valuable to the outsider. We have received a copy for review and can commend the book heartily, but unfortunately no price was stated.

GAS ENGINES AND PRODUCER GAS PLANTS is the title of a book by R. E. Mathot, M.E., published by the Norman W. Henley Publishing Co., 132 Nassau St., New York. 314 8-vo. pages illustrated. Price $2.50.

This work is a translation from the original French manuscript by Waldemar B. Kaempffert, with a preface by Dugald Clerk, the well-known English authority upon gas engine producers. The subject of power plants in which gas producers and gas engines are used is one of increasing importance and one that is being investigated extensively by engineers. This book treats the subject in a simple manner, describing the process of gas manufacture and the auxiliary apparatus used in gas producer plants. It deals mainly with engines and producers of small and medium size, discussing quite fully practical points regarding the operation of such plants. Ten chapters of the book are devoted to gas engines and their details and five chapters to gas producers of different types.

STEAM PIPES. . THEIR DESIGN AND CONSTRUCTION. By William H. Booth. Published by the Norman W. Henley Publishing Co., 132 Nassau St., New York. 187 8-vo. pages illustrated. Price $2.

Mr. Booth, who is a well-known English consulting engineer, has written extensively for the technical press, both in this country and in England. This is the first book that we know of to be published on the subject of steam pipes, and the information that he has gathered in regard to piping for power plants will prove valuable to engineers who have such plants to design. There are numerous tables, and the various practical points that must be regarded in laying out and operating a power plant are duly considered. Mr. Booth, the writer, says in the preface that the engineer will refer in vain to his various text books for information upon steam piping, and the object of his treatise is to supply the deficiency. He furnishes also tables of sizes of valves which will prove useful.

THE TEMPERATURE-ENTROPY DIAGRAM. By Charles W. Berry. Published by John Wiley & Sons, New York. 134 12-mo. pages illustrated. Price $1.25.

The Temperature-Entropy Diagram is gaining in favor as a means for analyzing the thermal changes taking place in gases and vapors

MACHINERY.

June, 1905.

HIGH-SPEED PLANERS.

A DISCUSSION OF THE MOST DIFFICULT PROBLEM NOW BEFORE MACHINE TOOL DESIGNERS—THAT OF ADAPTING PLANERS TO THE USE OF HIGH-SPEED STEEL.

A. L. DE LEEUW.

A. L. DE LEEUW.

With the advent of high-speed tool steel, the demand has come for high-speed machine tools. This demand could easily be satisfied in a great many cases. The ordinary lathe, for instance, was generally run at such low speeds that it was possible to speed up the countershaft, thus preserving the same pull on a piece of given diameter; or, in other words, raising the amount of power consumed by the lathe. Boring mills, boring machines and the like, could be treated in a similar manner. In many cases this was not quite sufficient; the machine was not up to what the tools would stand, and as a consequence machine-tool builders got out what they called their rapid reduction, or rapid production, lathes and boring mills. In these machines, the horse-power consumed by the machine was raised by increasing belt width and speed, and by strengthening the gearing, and in most cases also the frame work. This is all very simple and, as one prominent tool builder expressed it, there is no reason why a lathe could not be designed which would take a cut a foot deep, with a foot of feed, and running a mile a minute, provided the tools would stand such a cut—and, provided somebody could be found willing to pay for it. This statement may be slightly exaggerated but it expresses the fact fairly well, that limits in that direction are far away and not yet reached by a good deal. All the tools mentioned are machines in which the tool is all the time in contact with the work; they are rotary machines. An entirely different problem presents itself, however, when an attempt is made to increase the speed of reciprocating machine tools, such as planers, shapers and slotters. The planer problem has been attacked a number of times and by a number of people, but with indifferent result, so far. It may be well, therefore, to look into the matter, and try to find out what are the essential requirements of a high-speed planer, what difficulties one meets, and finally, as a result, how to overcome them.

For a long time all efforts were directed toward increasing the return or backing speed. Return speed was the great selling point of planers. This is the case even now, though I fear, not deservedly so. Let us take a planer running at a cutting speed of 20 feet per minute, and having a return speed of 80 feet per minute. Let us try to find out how much is gained if this return speed is increased to 100 feet. Suppose a cut 400 feet long has to be taken. This does not mean that the piece of work is 400 feet long but that the total of a certain number of cuts is 400 feet. The piece may be 10 feet long, and may require 40 cuts, which is equivalent to one cut 400 feet in length. The time for the cut is 400/20 = 20 minutes. The time for the return is 400/80 = 5 minutes. Total 25 minutes. If the return speed is increased to 100 feet, then the time for backing is 400/100 = 4 minutes; while the time for cutting is still 20 minutes, making a total of 24 minutes. This shows that by increasing the return speed from 80 feet to 100 feet, the time saving is one minute out of every 25 minutes, or 4 per cent. This figure is a little bit better than the actual showing would be, for the time of reversing—that is, for slowing down and speeding up again—has not been considered. In order to get this increased speed certain things have to be done which cost money and, worse than this, become a source of weakness to the planer. The countershaft has to be speeded up, or the belt width must be increased so as to get along with less gear reduction, or planer shafts must be run at a higher speed, causing increased wear, and liability of sticking. In short, it becomes a question whether the "game is worth the candle." It is doubtful in my mind whether 100 feet return will make a better showing at the end of the year than the 80 feet.

The amount of brains, energy, skill and experience brought to bear on this question, makes me think of hunting a rabbit with a six-inch quick-firing gun. Of course, this increased backing speed was the only game in the woods up to the time when high-speed tools made their appearance. It is different now. Both cutting and return speeds are taken in hand. Not only is the cutting speed increased, but a number of attempts have been made to get the benefit of various cutting speeds, to suit various conditions. A planer may be called upon to work on different kinds of materials, of all hardnesses, and with tools of all kinds of stand-up qualities. All sizes of cuts may have to be taken; all kinds of finished surfaces may have to be produced. The work itself may be of all grades of stiffness, and of any weight from the smallest piece up to 50 or 60 tons. All these different conditions call for a planer which should be flexible. It should be possible to plane slow or fast, and to return fast or faster. It should be possible to do this without spending much time in changing the drive. To show why all this is necessary, I will give here a few examples of conditions which may prevail, and of the way the planer should run to meet those conditions.

I. The work is a heavy cast-iron piece of considerable hardness, and with plenty of stock to remove.

In this case, the planer should run fairly slow on the cut, say about 20 or 24 feet, and take heavy cuts. A tool will stand such heavy cuts at low speeds better than when running at high speed with light cuts. The amount of metal removed per hour will be as much or more. Besides, the table and the work having to travel a lesser distance for the removal of a given quantity of stock, the waste of power (used merely to move table, load and mechanism) is less. The wear on the planer itself is also less. It should never be forgotten that the amount of metal removed is the object. The return speed should be moderate, as the quick starting and moving of a heavy load is liable to strain the planer mechanism severely.

II. The work is heavy, but has relatively little stock to remove.

In this case, the cutting speed may be as high as the tool will stand, but the return speed should be kept within moderate limits, and for the same reason as under I.

III. The work is of light weight, but stocky, and much metal has to be removed.

In this case, the cutting speed should be moderate, but the return speed may be high.

IV. The work is light, and has little stock to be removed.

In this case, both cutting and return speeds can be high.

There are several other things one should observe, however.

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if one wants the best results. For instance, it is of little benefit to have a high return speed on short stroke. This simply results in wearing the planer without accomplishing any good. Again, where the work is steel, a fairly high cutting speed may be used, even if there is much metal to be removed; for most high-speed steels work better at a high speed on steel than on cast-iron; so much so, that some tool steels do not show up well at all when cutting steel unless run at a decidedly high speed. Where brass is to be planed, high cutting speed may be used; but with some bronzes, a low cutting speed is absolutely necessary, if one does not want to tear the work. It is plain, therefore, that a machine which offers only one cutting speed and one return speed, is far from approaching the ideal construction.

In addition to all this, there is something else to be considered, which tends to make the problem still more complicated; it is that, though the tool may stand a certain speed when cutting, it will not stand this speed when entering the work. It is well known by this time that most high-speed steels stand shock but poorly, and for this reason cutting speeds of planers are frequently kept down, though all other conditions may be favorable for high speed.

In order to get a clear understanding of the difficulties one meets in trying to solve the planer problem, I will divide planers in three groups, viz.: Belt-driven planers, motor-driven planers, with some auxiliary mechanism between the motor and the machine proper, and direct-connected motor-driven planers. The first kind, being the oldest, ought to be treated respectfully; but it is not likely to get the job. The belt-driven planer has some inherent limitations which defy ingenuity. Its most troublesome weakness lies in the fact that the amount of horse-power taken by the planer depends on belt width and belt speed. To increase the width means increased difficulties of shifting, increased pressure on the bearings and increased weight of the pulleys. To increase the belt speed means increased tendency to slip, increased shaft speed, and with it, increased difficulties of lubrication. And after all, there are certain limits even if one is willing and able to overcome the above-mentioned difficulties. Belt width cannot be increased indefinitely and neither can belt speed. To illustrate, I will take for example some planer running the old-fashioned way, and see what must be done to double its speed, both for cutting and for return.

Belt-driven Planers.

Suppose the cutting speed to be 20 feet, and the return speed 60 feet. Suppose further, the cutting pulley to be 30 inches in diameter for 4-inch belt, and the return pulley to be 24 inches diameter for the same width of belt. The belt is supposed to travel 50 feet for one foot table travel, which would give a pull at the table rack of $50 \times 4 \times 50 = 10{,}000$ pounds, figuring on 50 pounds pull per inch width of belt. The cutting pulley will have to run 128 R. P. M. for 20-foot table speed; and the return pulley will have to run 384 R. P. M. for 60 feet return. The speed of the cutting belt is 50×20 feet $= 1{,}000$ feet, and the speed of the return belt is 2,400 feet.

If we now go to work and double the speed of the countershaft, so as to get 40 and 120 feet speed of the table, we will have to increase the speed of the cutting belt to 2,000 feet per minute. The return belt will run 4,800 feet; and when the return belt is on the tight pulley the tight cutting pulley will have a circumferential speed of $30/24 \times 4{,}800$ feet $= 6{,}000$ feet. A speed of 4,800 feet of the belt is possible, though not desirable. By using pneumatic pulleys (pulleys with perforated rim), slippage may be overcome, but the belt is liable to flap. A circumferential speed of 6,000 feet for a cast-iron pulley is unsafe and, generally speaking, steel-rimmed pulleys have not enough side stiffness for a shifting belt.

When returning, the pulley shaft runs 768 R. P. M. Though this speed is not at all phenomenal, it is an awkward speed for good lubrication, especially with a belt tugging at a shaft. Good designing may overcome this difficulty, but it is a difficulty nevertheless. There is, however, another difficulty which cannot so easily be swept out of the way. Increasing the speed of the pulleys increases the horse-power delivered by the belt, and also the momentum of the pulleys and other moving parts. The horse-power increases in direct ratio to the speed; but the momentum changes as the square of the speed. When shifting, therefore, four times the momentum of the parts must be stopped by double the belt power; so that, as will easily be seen, there is double the tendency to slip. To tighten the belts more is no solution for this would lead to other troubles. It would be necessary, therefore, to change all the leading dimensions given above; and even then, no set of dimensions will overcome all the difficulties at once. And, even though one may be satisfied with the mechanical arrangement of the planer, the result obtained is not at all what one should have; for there is only one cutting speed and one return speed. The cutting speed being high, the planer becomes useless for such work as requires slow cutting. The next step would be to use a variable speed countershaft, either by interposing a set of cone pulleys between the line and the counter, or by using one of the many variable-speed devices now on the market. However, if this is done the return speed goes down with the cutting speed, which, of course, is undesirable.

A number of planers have been furnished with a countershaft which gives a variable speed to the cutting pulley, while the return pulley runs at a constant speed. This object may be reached in different ways. One might have two countershafts; one with a variable-speed device for the cut, and the other a simple countershaft for the return. This is a better arrangement, though not at all free from objections. There are still the same limitations to high return speed, and, besides the return speed being constant, it must be chosen low enough for the most unfavorable conditions, that is, for heavy load and short stroke. One of the ways in which this arrangement is carried out is the Reeves variable planer countershaft. This arrangement, and many others of similar construction, is handy to operate and is a decided improvement over the old one-speed planer; but the peculiar conditions under which a planer works are hard on the countershaft, and it becomes necessary to rate its horse power low if one wants to keep the contrivance out of the hands of the doctor.

In order to get variable return as well as cutting speed, one might use two of these countershafts. This would solve the problem so far as speeds are concerned; but the other objections, enumerated above, would still exist. The countershaft might be driven by a motor; either placing the motor on the floor, against a wall or post, hanging it from the ceiling, or putting it on top of the planer; then belting over to the counter, or by gearing the counter to the motor. The problem remains the same, except that a new and troublesome element has been introduced, viz., the motor. In order to see what influence the motor has on the planer problem, we will have to study the reversal of the planer.

The Action during Reversal.

This reversal takes so little time that it is very hard to notice all that happens, by simply looking at it. A little reasoning is necessary to see it clearly. Suppose the planer is at the end of a cutting stroke. The dog strikes the tappet, and begins to move it. This starts the movement of the belt eye, guiding the cutting belt. This belt is moved from the cutting pulley onto the loose pulley. Meanwhile the planer keeps on moving, by the momentum of the moving parts, especially the pulleys. The pulleys are moving relatively slow; but even at this slow speed, they would be able to move the planer several feet if nothing else happened. Immediately after the cutting belt is moved onto the loose pulley, the belt-eye guiding the return belt, begins to move, and brings this belt onto the return pulley. This belt is running in opposition to the pulley and therefore has a braking effect as soon as it comes in contact with the pulley. The pulley slows down, and so does the planer. The movement of the belt-eye also becomes slow and, by the time the full width of the belt is on the return pulley, this pulley, the planer, and the belt-eye have come to a standstill. However, this is only momentary. The belt begins to move the pulley in the opposite direction. As long as the pulley has not acquired the full speed of the belt, there will be slippage. This slippage takes place, therefore, during all the time that the planer slows down and picks up speed again in the new direction. If the planer comes to a standstill, before the return belt is fully on the pulley, the act of shifting this belt comes to an end, and the planer has to start on

the return stroke with less than the full width of the belt on the pulley. This will actually happen when the speed of the cutting pulley (and therefore its momentum) is too low, and it will happen especially when there is a heavy load on the planer, or when the cut is taken up to the extreme end of the stroke, so that the momentum of the pulley has to overcome the resistance of the cut.

When the shifting is not complete, the belt is apt to suffer; moreover, the planer may come to an unexpected standstill, or drag along on the reverse stroke with continuous slippage. This is one reason why a low belt speed for the cut is not advisable; for, in that case, the momentum of the pulley is not enough to carry the shifting through to the end. When the reversing belt enters on the tight pulley, it must start this pulley, and bring it up to a high speed. The reverse pulley is generally smaller than the cutting pulley, so as to get sufficient speed without making the countershaft pulley too large. The belt, acting on this small pulley, must give momentum to a large one. This is the reason why cutting and return pulleys should be made as nearly equal in size as is practical.

Motor-driven Planers.

We have drifted away from the motor, but purposely, for we want to show what the motor will have to do. Suppose the motor is a shunt-wound machine. Such a machine tends to run at the same speed, regardless of load. If the armature shaft of a shunt-wound motor is clamped, so as to prevent it from turning, and current is allowed to flow through the armature, the amount of current will be limited only by the resistance of the copper bars (or wires) on the armature, and by the resistance of the wiring between the dynamo and the motor. This resistance is very low, and we will have a short-circuit. Leaving the resistance of the outside wiring out of consideration, the amount of current going through the stationary armature can be figured, if we know the resistance of the armature conductors. Suppose this resistance is 1/10 ohm (which is really higher than will be found in a good motor) and suppose the voltage to be 220; then $220 \times 10 = 2{,}200$ amperes will flow through the armature. This, of course, is sufficient to burn out the motor unless protected by a circuit-breaker or fuses. Suppose the normal load of the motor is 100 amperes; then, when these 100 amperes flow against a resistance of 1/10 ohm, 10 volts will be lost in the armature. There are still 210 volts left, to be counteracted by something else. This something is the counter-electromotive force generated by the armature when running at its proper speed. Suppose the motor runs 630 R. P. M.; then these 630 R. P. M. must generate an electromotive force of 210 volts. This is three turns per minute for every volt. If, for some reason or other, this speed drops, then the 210 volts will not be fully made up, and more amperes will flow through the armature. Suppose, for instance, the speed of the motor drops to 600 R. P. M. This is not a very great drop as far as speed goes, but the consequences would be very noticeable. This drop of 30 R. P. M. would cause a shortage in the counter-electromotive force of 10 volts, which means that so much additional current would have to flow through the armature, as to cause a drop of 10 volts by the resistance alone. As this resistance is 1/10 ohm, the current will have to be 100 amperes and the total amount of current flowing through the armature will be 200 amperes, or twice the full load current. As, in reality, the resistance of the armature is much less than was assumed here, the increase of current will be much greater than was figured. This increase, however, is great enough to cause harm to the motor if it takes place during a sufficiently long time, or if it is repeated frequently. This drop of speed is exactly what happens if the motor is geared or belted to a planer countershaft, and this is why adding a motor to a planer is adding trouble to trouble. The countershaft, being driven by the motor, tends to keep its speed. The lower pulleys *must* come to a standstill every time the planer reverses; and, though this standstill lasts only an instant, there is still to be considered the decrease and increase of speed before and after the standstill is reached. Countershaft and machine pulleys being connected by a belt, there will be a tug of war, every time the planer reverses, and the consequence is that the belt slips and the countershaft goes down in speed. This is the reason why an ammeter shows such antics when in circuit with the motor which drives a planer.

This momentary overload of the motor makes it necessary to use a much larger motor than is required to drive the planer, and take the cut, and even then conditions must be favorable to avoid overload and sparking. If the motor is on the floor, and belted to the countershaft, the bad results are materially diminished. In general, it is advisable to have as much belt as possible between the motor and the machine, as this allows of more stretch and slip, and thus reduces the slowing-down effect on the motor. The overloading of the motor is at its worst when it is geared direct to the countershaft. Various means have been suggested to relieve the motor; among them are compounding the motor, putting a flywheel on the armature shaft, and the combination of those two. As to compounding the motor, this actually relieves it; for a compound wound motor is more elastic as to speed. However, it has the disadvantage of speeding up when the load is light; that is, just before the cut starts. As a consequence, the tool hits the work at a high speed, and this, as we know, is very objectionable. Another point, though of minor importance, is this: Every motor makes a humming noise, some more than others. This noise is not noticed after a while, because the noise is of the same pitch and the same intensity all the time. A compound wound motor, however, slows down and speeds up again at every reversal. This change of speed changes the note of the motor, and one notices the noise as soon as one comes within hearing distance, even outside the shop. Of course, this objection is not enough to condemn the compound-wound motor, but it is certainly not a point in its favor.

Putting a flywheel on the armature shaft is done so as to carry the motor over the dead point, and to prevent it from slowing down, and thus taking an excessive amount of current. It does this, it is true, but it compels the belt to slip the full amount, and consequently, is hard on belts and bearings. The combination of compound motor and flywheel strikes me rather as a joke; the motor is compounded, to allow it to slow down, and the flywheel is put on to prevent it from doing this. I found that the best way of all, was to use a shunt-wound motor, and make it big enough; and further, to keep as many belts as possible between the motor and the machine, and also to make them as long as possible.

All things considered, driving a planer by hitching a motor to the countershaft is not much better than a makeshift, and it is not going to be the ultimate way, if I am any prophet at all.

Planers Operated by Clutches

As the shifting of the belts constitutes a limit to the possibilities of a planer drive, it has long been recognized that it would be advisable to get along without them. This led to the clutch-driven planers. All kinds of clutches have been designed to do the trick, a few good, but most of them bad, worse, or impossible. It was readily recognized that positive clutches would not do, so the inventors and designers settled down to the friction clutch. It was not so readily seen, however, that the manner of throwing in the clutch, or rather, the method for getting pressure behind the clutch, was of only secondary importance. So far as I can see it makes very little difference whether the clutch is thrown in by air, electricity, a lever, or the sole of my foot; its limitations, and the troubles it causes, lie in something else. The whole story is this, a friction clutch slips, or else it does not slip. When it slips, it does not work; and when it does not slip, then it is a positive clutch, and therefore, no good for a planer. The ideal friction clutch for a planer should slip enough to pick up the load gradually, and yet quickly, and should not slip at all when taking the heaviest cuts the machine has to take. This sounds simple, but to make such a clutch is a different thing. There are at the present time only two styles of clutches which are considered for a planer drive: the magnetic, and the pneumatic clutch. The first one has been cursed so often and so heartily that I am afraid the bottomless pit is not deep enough for it. The pneumatic clutches have not reached this stage—yet. Whether they ever will, I am not prepared to say. But the chances are somewhat in favor of the pneumatic clutch, and this does not lie so much in its qualities, as in the fact

that the average tool builder, tool designer, tool user, and the operator know more about air than about electricity. It would require too much space to give a somewhat complete essay on magnetic clutches. It may be well, however, to point out why they have failed to come up to the high expectations they once raised.

A magnetic clutch consists of a pair of iron-clad electromagnets, and an armature, or keeper, which is attracted now by the one then by the other, according to which magnet receives the current. A simple reversing switch, operated by the dogs or by hand, controls the current. Nothing can be simpler. A magnetic clutch is a friction clutch pure and simple; the magnet turns free on the shaft, and is driven by a gear. The armature is keyed to the driven shaft, and magnetism simply serves to press one member against the other. Therefore, all the troubles the friction clutch is heir to, appear in the magnetic clutch. The sum and substance of these troubles was given in the sentence, "A friction clutch slips, or else it does not slip." It was soon found out, that a magnetic clutch slips, and this caused wear. Some makers drilled a large number of holes in the surface of the clutch, and filled these holes with cork plugs, which would last sometimes a whole day, though generally much less. Other makers substituted hardwood for the cork, and made the plugs smaller in number and larger in area.

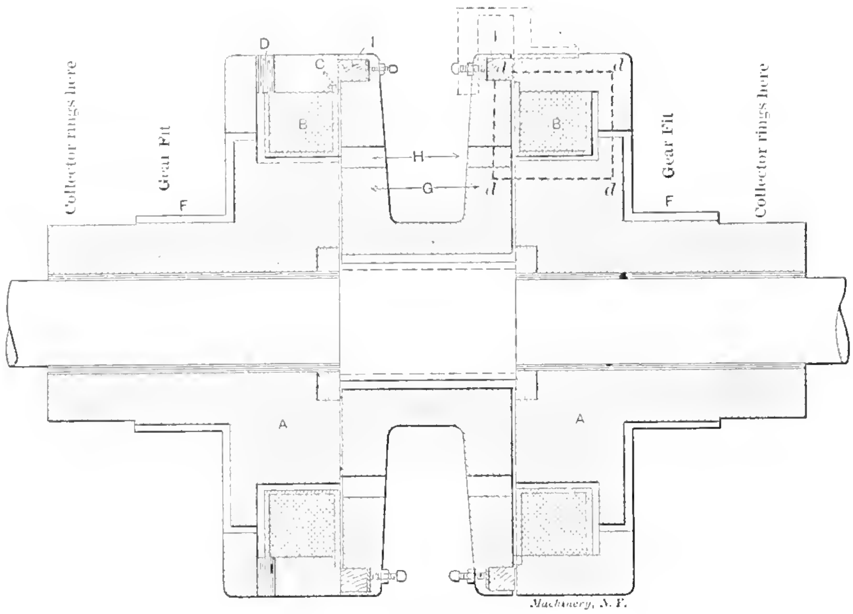


Fig. 1. Section of Magnetic Clutch.

Fig. 1 shows a section of a magnetic clutch and its armature. It is not drawn to scale, and should only be used as illustrating the principles of construction. *A* is a steel casting (the clutch), bored out to receive a bushing, which revolves on the shaft. It contains a coil of insulated copper wire, *B*. This coil is placed in a brass cage, so as to be easily inserted and removed. Space is left between the steel casting and the brass cage, for the purpose of ventilation. Ribs on the brass cage prevent it from shaking, while a number of screws, *C*, hold the cage in place. The annular space around the cage is connected with the atmosphere by a number of holes, *D*, drilled through the steel casting. The leads are carried off through channels, and are connected to the collector rings. Brushes deliver the current to these collector rings. The part, *F*, of the clutch is turned up for a gear fit, and is provided with a keyway. The armature is a hub, with a couple of flanges, one for each clutch. The flanges, *G*, are provided with a number of holes, *H*, for ventilation, and a number of other holes, *I*, into which hardwood blocks are fitted. A washer and setscrew behind each block serves to set them up, so that all project an equal distance above the flange. The path of the magnetic circuit is indicated by the dotted line *d-d-d-d*. The wood blocks serve two distinct purposes. In the first place, and as was mentioned, they provide the wearing surface; it is for this purpose that they are made adjustable. But there is another purpose, and an entirely different one. If the current is turned off in an electromagnet, the iron will lose its magnetism, but not immediately. At first the magnetism diminishes very rapidly, but this drop becomes slower and slower, and an appreciable time goes by before the magnet has lost practically all its power. This phenomenon is much more marked when the armature is in contact with the magnet. It is called residual magnetism. This residual magnetism is the bugbear for the designer of a magnetic clutch.

Suggestions in Regard to the Design and Operation of Magnetic Clutches.

Fig. 2 shows a pair of clutches with their armature in diagrammatic form. The armature is supposed to be in metallic contact with clutch *A*, while there is supposed to be an air gap of one-eighth inch between it and clutch *B*. It is well known that very little current is required to force a large amount of magnetism (or, as it is commonly expressed, a great number of lines of force) through a circuit of iron or steel, and that a great many times that amount of current is required to force the same number of lines through the same length of any other material as, for instance, air, or water, or brass. How many times depends on how nearly saturation is reached. Under certain conditions this number may be 3,000, for example. This means that the same amount of current which will force a certain number of lines through 30 inches of steel, will force the same number of lines through 1/100 inch of air, or any other non-magnetic material. A very little residual magnetism in clutch *A*, therefore, is capable of preventing clutch *B* from pulling the armature over to its side, even if *B* is magnetized the full amount. The wood plugs, mentioned above, serve the purpose of keeping armature and clutch separated, so as to keep the residual magnetism down to a minimum. This they do, but at the expense of the efficiency of the clutch. As explained, the existence of an air gap between clutch and armature makes it necessary to employ a very much heavier current in order to get the same amount of pull. It was found that about 3/64-inch air gap was necessary on a 33-inch clutch. Not only does the air gap allow the magnetism to discharge more quickly, but whatever magnetism is left has not the same holding-on power as when the clutch and armature are metal to metal. Even with the air

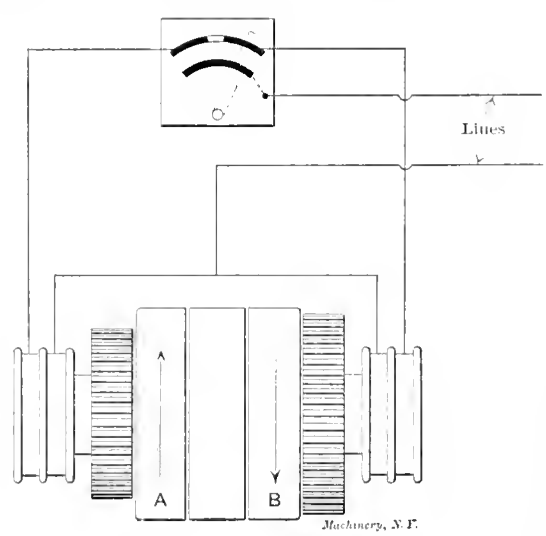


Fig. 2. Diagram of Magnetic Clutch and Connections.

gap, an appreciable amount of time lapses before the other side of the clutch gets power enough to pull the armature over to its side. This is due to the fact that a high degree of saturation of the clutch is used, and that a piece of iron or steel requires some time before it reaches this state of saturation.

I tried another way of overcoming the bad effects of residual magnetism and, so far as I know, with good result. A switch was used for reversing which would reverse the magnetism in one clutch for such a length of time as was necessary to kill

the residual magnetism. The current was then turned on in the other clutch and, though it is true that it took just as long to bring this clutch up to the point of saturation, it is also true that the clutch did not need to come to this point before it pulled the armature over to its side. Of course, this was because it did not have to overcome the residual magnetism on the other side. The actions of the switch were controlled by the dogs. The clutches used in that case had cork plugs projecting about 1/32 inch above the metal. This 1/32 inch lasted about 5 minutes, after which there was metal-to-metal contact. But this caused no trouble: in the first place residual magnetism was killed, and in the second place these corks acted as so many lubricators, thus reducing the wear to such an extent that it was not noticeable during the six weeks these planers worked under my eyes. I never heard of any trouble on that score with these same planers, though I could not swear that there isn't. The scheme of preserving an air gap between clutch and armature seems a very simple one, and so it is, as far as construction is concerned, but it has a number of consequences which are not desirable. First, there is to be considered the amount of current consumed by the magnets. Not that it makes much difference in cost whether one or two amperes are used, but more current means more heating of the clutch and, in order to avoid this, the clutch has to be made larger, which in its turn means more momentum at the moment of reversal. Another objection to the wood blocks, and to the cork, too, for that matter, is that the number of square inches of section of the path of magnetism must be a certain minimum, in order to get the necessary pull, for this pull depends on the number of square inches, and the number of lines per square inch. The wood blocks take up a large amount of area which, of course, is lost to the magnetic circuit. This makes the clutch larger again. If all the area of the clutch outside of the coil were metal its width could be less, the average diameter of the coil could be greater, and the heating effect would be less.

In order to drive the planer, and especially in order to reverse, there must be a certain torque on the driving shaft. This means that there must be a certain magnetic pull and a certain lever arm to work on. Suppose the clutch must transmit 20 H. P. at 100 R. P. M., then it transmits 79,200-inch pounds per revolution. Suppose the mean diameter of the friction blocks is 14 inches, then the pull at the blocks is 79,200 divided by the circumference of a 14-inch circle, which is 1,800 pounds. Suppose, further, that the coefficient of friction is 10 per cent; then the magnetic pull is 18,000 pounds. It is plain that this pull might be less, if the mean diameter could be increased. For this reason I suggest the alteration shown in Fig. 1 in dotted lines. The friction blocks are carried entirely outside the magnetic circuit, and are supported by a light framework of bronze. This frame needs only sufficient section for mechanical strength. It can be made as wide as may be necessary to give the friction blocks ample area. Being at a large diameter, it allows the clutch body to be made smaller. It adds to the weight of the revolving parts, and that at the worst point, far from the center; but the total moment of inertia of the clutch need not be more than where the friction blocks are in the magnetic circuit. This circuit, being uninterrupted, becomes more compact and therefore the leakage is less. I have applied this to a large planer, but it is still too early to give results. I hope to be able to do so later.

Some time ago I indulged in some experiments, in order to find out if it were not possible to quicken the action of the magnetic clutch. Though these experiments were not carried out systematically, and the results were not put to practice, their outcome may be of interest to some of the readers of this article.

Fig. 3 shows a diagrammatic view of the experimental arrangement. *A* and *B* were two clutches, strapped back to back, so as to make one sliding member. *C* and *D* were two other clutches, mounted on the shaft, and the necessary collars were provided, to prevent *C* and *D* from moving endwise. *A* and *B* were allowed one-eighth inch endwise movement. This arrangement formed an ordinary clutch with the armature, with the exception that the armature itself was provided with coils. Clutches *A* and *B* received current all the [illegible] in the same direction. Clutches *C* and *D* also rece[illegible] all the time, but this current could be reversed. The re[illegible] was done by means of double-pole double-throw switches which were mounted against the wall. When both handles were up, the armature was up against *C*; when the handles were down, it was up against *D*. The polarity of the magnets is indicated by *S* and *N*; *S* indicating the south pole and *N* the north pole. As similar poles repel, and opposite poles attract each other, the reversal of the poles *C* and *D* must bring the armature from one side to the other. It did this in such a short time that it was impossible to estimate the amount. The snap of closing the switches was apparently simultaneous with the blow of the shifting armature. In order to bring the armature in the central position, only one switch was reversed, making both clutches repellent. There was, of course, no blow, and it was therefore somewhat difficult to make observations as to the time consumed to push the armature away from the clutch. Though I am not prepared to say how little time it took, this much, I know that it was not possible for me to notice any time at all. Of course the experiment was crude, and finer observations would very likely show somewhat different results. The wiring of clutches *A* and *B* was now cut out and the clutch treated like an ordinary magnetic clutch, that is, the current was sent to only one side at a time. There was metal-to-metal contact, as the

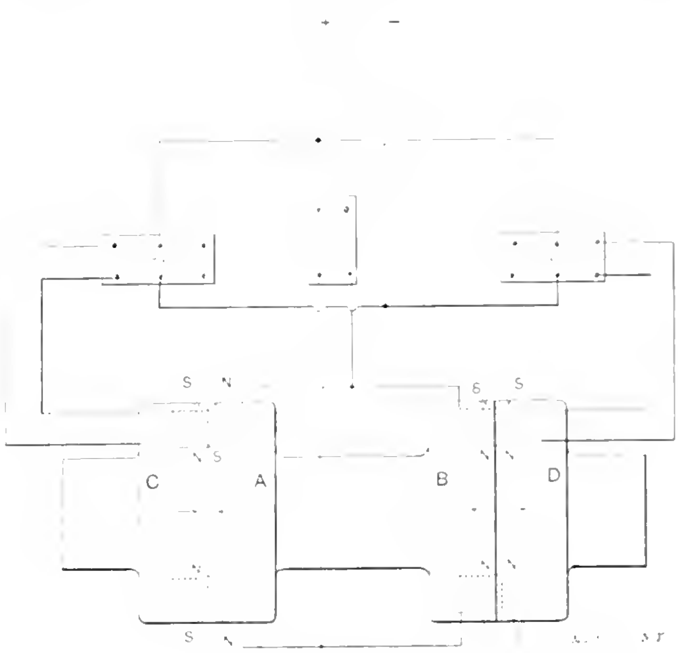


Fig. 3. Apparatus used to Test Speed of a Specially Designed Magnetic Clutch

corks were old and compressed. If the current was turned off from *C*, and turned on in *D*, from 6 to 7 seconds would pass before the armature would shift. This time was diminished to about one second and a half, if brass distance pieces about 1/32 inch thick were inserted between clutch and armature.

I am sorry to say that I never had an opportunity to use this arrangement on a planer. Of course the difficulty of slippage was not overcome, but the quickness of action was improved remarkably.

Much more could be said about magnetic clutches, and I am sure very much could be done to improve them, but it is the question, whether the game is worth the candle, and whether life is long enough to spend a large portion of it on such an unthankful proposition.

One trouble experienced with magnetic clutches is their heating, when running on short stroke. It is nothing strange to see the smoke come out of the wood blocks. This is due to an insufficient area of the friction blocks. By placing the friction blocks outside the magnetic circuit, and by using the system of repulsion and attraction described above, most if not all of the troubles might be overcome. I hope later on to have a chance to try this, and to announce results, good or bad.

Pneumatic Clutches and other Devices for Planer Reversal.

The second kind of clutch is the pneumatic clutch. A complete description of this device would take up too much space, and is, in itself of so much importance that nothing but a complete essay will do it justice.

One of the most modern clutches, though old in principle is a Weston clutch, whose leaves are pressed against each other by compressed air. This construction has some inherent advantages. One is that the power transmitted can be made as large as desired by simply using more leaves. Another is that the leaves themselves offer a large frictional area, and that this again can be made still larger by simply multiplying the number of leaves. Care must be taken to have all parts self-contained on the driving shaft, so as not to bring any end pressure against the bearings, and another point of the greatest importance is to avoid leakage of air. These points, however, appeal to any good mechanic, and for that reason are not liable to cause such serious trouble as the magnetic clutch.

Another type of pneumatic clutch uses friction cones lined with wood blocks. Whatever clutch is used, the difficulties remain the same as with belt-driven planers, when high speed is the object. These difficulties might be overcome, if it were possible to devise a clutch of small bulk and weight, great starting power, and requiring only a small gear reduction. Thus far such a clutch has not been designed, and is not likely to be designed at any time, as some of its requirements are in direct opposition to some of the others. An attempt has been made to have the clutch nearly positive in its action, and thus give it great driving power, and then adding some device which will relieve the planer of shock. Various devices have been brought out from time to time, and were illustrated in different papers. They are used with both belt- and clutch-driven planers.

It has been proposed to make the table rack sliding under the table, and have it butt up at both ends against strong helical springs. I have never seen a planer thus arranged, but I fear that this arrangement is weak and liable to cause any amount of trouble. Others have placed the driving pinion loose on its shaft. Its hub was provided with a clutch tooth arranged like a cam, or rather, part of a helix. A similar clutch was mounted on the same shaft and made to slide over a key. A strong helical spring behind this clutch held the two cam surfaces in contact. When the pinion shaft began to turn, it had the tendency to take the pinion along, by the friction of the cam surfaces. It would thus start the table, but at only a part of the ultimate speed, as the clutch was sliding back at the same time. When this clutch was as far back as it would go, a projection would engage a corresponding projection on the pinion hub. From that moment on, the drive was positive. This arrangement again is weak and unfit for large and powerful planers. To show that I have given this subject some consideration, I will here describe a device which I got out some years ago, but though I consider it of interest, as showing one of the different roads pursued to get to a high-speed planer, I do not think it is the final solution. It is not patented and anybody is welcome to it.

Fig. 4 shows this arrangement. It consists of a cylinder, *A*, filled with heavy oil, in which a piston, *B*, moves. The piston is a nut moving over the screw, *C*. This screw is a part of, or attached to, one end of the pulley shaft of the planer, while the cylinder, *A*, is attached to the other end of this shaft. In this way, the device forms the coupling between the two parts of the shaft. The piston is guided by a key, *D*. It has a second keyway, diametrically opposite the first, which fits loosely over a throttling bar, *F-E*. This bar is made in two pieces, the stationary piece, *F*, and the rocking piece, *E*, and the latter is the real throttling bar. Suppose *B* is connected to the pulley end of the shaft. As soon as this begins to turn, the nut will have a tendency to go forward if it can do so; or, if not, then the nut will take cylinder *A* along, and thus drive the planer. In order to go forward, the nut must displace the oil in the cylinder and drive it from one end to the other. The oil has to travel through the opening left between piston and rocker bar *E*, which becomes smaller as the piston travels further, due to the slanting position of the rocker bar. This opening, being large at the beginning of the piston travel, but little resistance is offered to the movement of the piston, and of the cylinder, and thus, the planer remains at rest. As the opening becomes smaller the resistance increases, and soon a point will be reached where the piston starts the cylinder revolving. There is now a movement of both piston and cylinder, and the planer starts up, but not with its ultimate speed. As the resistance against the endwise movement of the piston increases, the speed of the planer increases also, until the piston is up against the other side of the cylinder, and the planer is traveling at its full speed. In order to give the piston a rapid endwise motion, the screw is made with a very steep lead (the angle of the thread was 30 degrees at the pitch diameter). The nut will travel in the opposite direction when

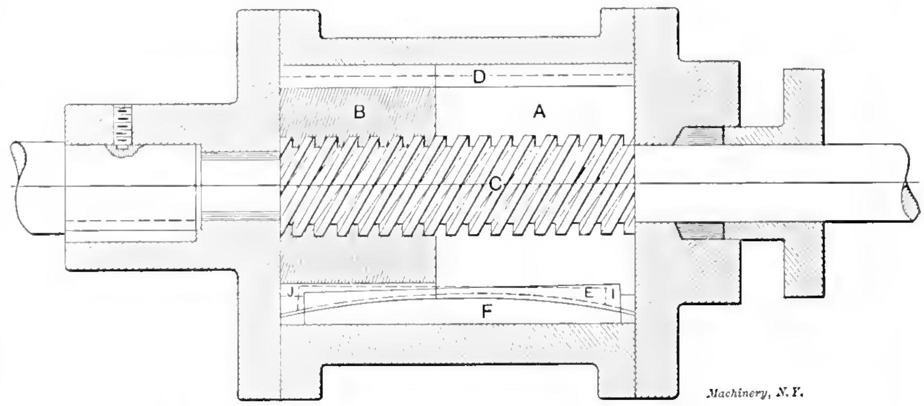


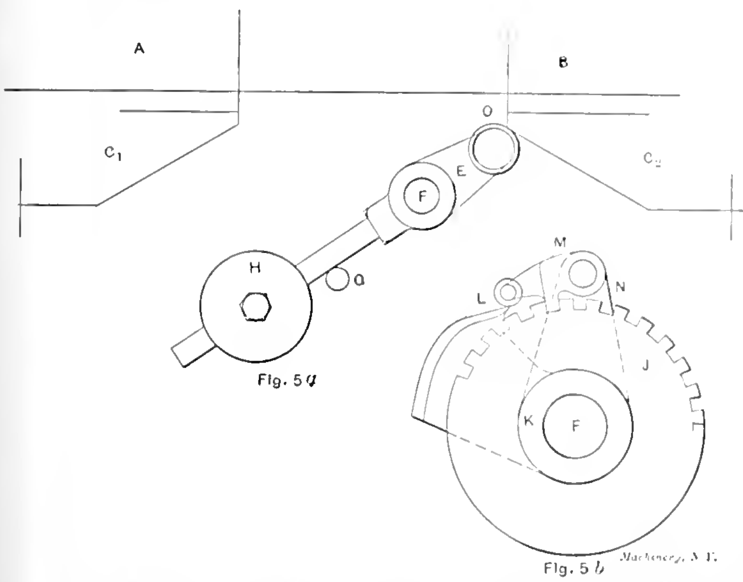
Fig. 4. Device to Provide for the Gradual Reversal of a Planer Table.

the planer reverses; it then forces the oil back to the other end of the cylinder. The taper of the throttling bar, however, is the wrong way. This is where the rocker bar does its fine work. The position of this bar at the beginning of the reverse strike is shown in dotted lines. As soon as the piston begins to move, pressure is brought to bear against the end, *I*, of the bar, while the end, *J*, is free to move. The bar will rock, therefore, and place itself in the proper position. This action takes place at the beginning of each stroke. The device worked very well, as far as I tried it, though I never tried it on a planer. Like a great many other devices of this nature, however, I consider it a source of weakness, and therefore to be avoided, as long as something better can be found.

Planers Driven by Direct-connected Motors.

The third group of planers are those driven by a direct-connected motor. For this style of drive, the motor is direct-connected to a driving shaft, without intervention of belts, clutches, or other mechanical devices. Such planer drives are now being built by the Electric Controller and Supply Co., Cleveland, Ohio. This system of driving a planer comes nearer to the ideal planer drive than any mentioned so far but it has some serious drawbacks. The motor is geared to one of the planer driving shafts. The planer is reversed by reversing the motor. Thus, all objections to starting up a planer at high speed, and to overcoming the momentum of revolving parts are obviated. When the planer is about to reverse, current is turned off, and the armature of the motor is short-circuited on a certain amount of resistance. Sometimes, not even this is done, and the current is turned on immediately in the opposite direction. Solenoid-operated switches control the motor; and they, in turn, are operated from a contact switch, operated by hand or by the dogs. The first solenoid-switch is operated direct from the tappet-switch; as soon as the motor has reached a certain speed a second solenoid-switch acts, cutting out starting resistance, etc.; the solenoids depending for their action on the speed obtained by the motor, i. e., on its counter-electromotive force. The field resistance is thrown in on the return stroke only, or on cutting and return stroke both, as may be desired. The drive is capable of working on short, as well as on long stroke; and it matters

not at how high a speed the table runs. This sounds very nice, and, in fact, it is nice, but there are certain draw-backs. Motors as they are commonly constructed have a speed variation not exceeding two to one. I do not mean to say that there are no motors with a greater speed range, but that they are the exception and not the rule. This means that with one of those motors the highest possible return speed is only twice as great as the lowest necessary cutting speed; for the speed range of the planer is, of necessity, the same as the speed range of the motor. Any motor with greater speed range must necessarily be larger and more expensive; and even then there is a limit. Four to one is an extreme range for one voltage. The Electric Controller and Supply Co. arrange some of their drives with the motor on the three-wire system, i. e., 110 and 220 volts, and thus increase the speed range; but this requires a large motor, the same as if the motor were run on one voltage only. Besides, the shops which use the three-wire system are a small minority. A planer driven this way was on exhibition at the St. Louis fair, and appeared to work very well—with the above limitations.



Figs. 5a and 5b, showing the Mechanism for Varying the Speed of Motor.

The idea of reversing the motor with the planer is not new. As early as 1899 I used a 20 H. P. reversible Westinghouse motor, direct-connected to a plate planer, for the Mare Island Navy Yard. This planer was built by the Niles Tool Works Co. The controller was furnished by the Cutler-Hammer Co., Milwaukee, Wis. The same style drive was used on a number of other plate planers, later on. Variable-speed motors were in their infancy then, so that it was not possible to use them for ordinary planers. (Plate planers plane both ways, and therefore run at *one* speed only.)

The Pond Machine Tool Co., one of the plants of the Niles-Bement-Pond Co., has in its shop a planer driven by a direct-connected Thompson-Ryan motor made by the Ridgway Dynamo and Engine Co., Ridgway, Pa. The motor has a speed range of 7½ to 1 on one voltage. It follows that the motor is a thing of might, and looms up in gigantic proportions alongside the planer. The tappet lever operates a controller, which starts a small motor. This motor, in its turn, operates the controller for the large motor. The entire outfit is large, expensive, and delicate. However, it does the work very nicely. It allows of a cutting speed as low as 20 feet per minute, and a return speed as high as 150 feet per minute. It may be called an interesting and successful experiment, from a mechanical standpoint. However, its cost and complexity do not recommend it for practical use.

A Solution of the Problem Proposed by the Author.

It has been my experience, that *one single* principle cannot govern a construction, if this construction shall serve a useful purpose. The science of engineering is the art of compromising. Some of this and some of that must be sacrificed, in order to get a really useful result. I am convinced that neither of the systems enumerated so far will lead up to a commercially successful planer. At the same time, all have certain points which it may be well to preserve. These considerations led me up to what I believe a good solution of the entire question. I combine the construction of the direct drive with that of the clutch- or belt-driven planers. Thus I get the advantages of the speed range inherent in the clutch-driven planer, with the speed range of the commercial motor. For example, take a planer driven by belts or a clutch, and having a cutting speed of 20 feet per minute, and a return speed of 60 feet per minute. These speeds are very moderate and obtainable in the largest size planers, without meeting any extraordinary difficulties. Let this planer be driven by a motor, running 500 R. P. M. Now, increase the speed of this motor to 1,000 R. P. M., and you have a planer with 40 feet cutting, and 120 feet return speed. Both the motor and the planer can be easily obtained. It remains to connect them in such a way as to get the greatest benefit out of the combination. Let us take a clutch-driven planer. While the planer is running on its cutting stroke of 20 feet per minute, I turn the field rheostat of the motor, until the planer speeds up to 30 feet. Just before the moment of reversing I turn the rheostat back to its original position, so that, at the end of its stroke, the planer runs again at 20 feet per minute. The planer reverses and starts up with an initial speed of 60 feet. Immediately after starting, I turn the rheostat to its highest point, bringing the motor up to its highest speed of 1,000 R. P. M., and making the speed of the planer 120 feet. Before the end of the stroke the speed is reduced again to 60 feet, and the planer reverses again at its low speed, thus doing away with the problem of braking and starting a large momentum. It is truly remarkable to see how quickly the planer responds to the rheostat, and how few inches of table travel are needed to slow down and to get speed up again. The slowing down is so rapidly accomplished that some precaution is necessary so as not to subject the planer to shock. The reason of this lies in the motor. When our motor runs 1,000 R. P. M., it does so in order to generate the necessary counter-electromotive force. The speed is high because the field is weak. The field strength becomes twice as great as soon as the rheostat is turned back to the first button. The motor, running now 1,000 R. P. M. in a strong field, generates a counter-electromotive force in excess of the voltage of the line, and therefore sends current back to the generator, and helps to drive other machines or light up the shop. This acts like a very powerful brake, and brings the motor down to its lower speed, almost instantaneously. The speeding up does not go quite so quickly, though, as I said before, only a few inches of table travel are required to bring the planer up to full speed.

The speeding up and slowing down of the motor at the proper time, can be accomplished in a great many ways, either electrical or mechanical. I have worked out various schemes, of which I will give one as an example. Fig. 5-*a* shows a sketch of the mechanism required. *A* and *B* are the dogs. Each, one is provided with a cam-shaped projection, marked C_1 and C_2. These projections are in different planes, so as not to interfere with each other's action and each projection operates a roller *D*. These rollers are held in levers *E*, pivoted on the shaft *F*. The levers are counterweighted, and in state of rest, but against a stop pin, *G*. A spring may be used instead of the weight *H*. In fact, this would be preferable, as the weight ought to be adjustable, and as this might take up too much room. Fig. 5-*b* shows part of the mechanism removed, so as to show the rest more clearly. *N* is a lever, fastened to *E*, and carrying a pawl, *M*. This pawl works both ways (forward and backward) on the ratchet wheel *J*. There are, of course, two pawls and two ratchet wheels; one for each lever, *E*. Both ratchet wheels are keyed to the same sleeve, *K*. This sleeve revolves around the stationary shaft or stud *F*. A cam or shield *L* (one in front of one ratchet wheel and one behind the other) is adjustable on the shaft. It will be seen that the shapes of the cam and pawl are such that the cam throws the pawl out of engagement with the ratchet wheel. The projection *C* gives the roller, and thus the pawl, a certain fixed amount of motion at the end of the planer stroke; while the counterweight, or spring, brings it back again to normal position. The sleeve *K* carries a gear wheel or sprocket, not shown in the sketch, which operates the rheo-

stat. The style of connection depends on the shape of rheostat, the arrangement of the planer, and other local conditions. Calling the similar rollers corresponding to projections C_1 and C_2, D_1 and D_2 respectively; the two pawls, M_1 and M_2; ratchet wheels, J_1 and J_2, and shields L_1 and L_2, where in the sketch the letters D, M, J and L have been used to refer generally to these parts, the action of the device is as follows: Projection C_1 strikes roller D_1 just before the end of the cutting stroke and depresses it. This moves pawl M_1, and thus ratchet wheel J_1. The rheostat is brought to the off position. As soon as the table reverses, the lever is free to resume its position, and does so under the pull of the spring or the weight. The ratchet wheel is moved back, until the pawl is compelled to climb to shield L_1, when the ratchet wheel is left free. The rheostat is thus set to a point somewhere between "off" and "full on." Any speed of the motor, between minimum and maximum can thus be had by adjusting the position of the shield. It should be remarked here, that the shield L_1 when as far back as possible, still intercepts the pawl, so that the ratchet wheel is free at the end of the movement, regardless of the speed of the motor. At the end of the return stroke, a similar cycle of operations is gone through. This time it is projection C_2, which operates on roller D_2 and thus on ratchet wheel J_2. This ratchet wheel is free to move, as the other pawl is held out of engagement by shield L_1.

It will thus be seen that any speed of the motor, between its minimum and maximum, can be had at the beginning of either stroke, and that the speed of the motor is always brought back to its minimum at the beginning of the stroke. In this way, the planer can have any cutting speed ranging from 20 to 40 feet per minute, and that, in combination with any return speed ranging from 60 feet to 120 feet. This range might be increased on small planers from 20 to 160 feet, and, by taking a motor with a speed variation of 2½ to 1 (which is well within practical limits), a range of 20 to 200 may be obtained. It will further be seen that any cutting speed may be had in combination with any return speed, so that all conditions of work can be accommodated.

An advantage incidental to this arrangement is worthy of notice. As the feed takes place at the beginning of the stroke, and as the table speed is always the same at the beginning of the stroke, the feed will always be accomplished in the same number of inches of table travel. With an ordinary variable speed planer, the feed is either too fast at the high speed, or takes up too much of the travel at the low speed.

Though the arrangement, as described, is not applicable except with motor drive, I think it a great step forward toward the goal, viz., a practical high-speed planer. A similar arrangement might be constructed, operating on a variable speed countershaft, or speed box, instead of the motor.

* * *

VARIABLE SPEED MECHANISMS.—2.

CONE, DISK AND SPHERE DEVICES.

The following review of United States patents on variable speed mechanisms is not exhaustive in that it covers all such devices that have been patented; neither is it claimed that all the best devices are shown, but those devices are shown which it was possible to find in a comparatively limited time for the search of the patent records for the last fifty years. Owing to the peculiar, not to say defective, classification of United States patents it would be impossible to present a complete review of variable speed mechanisms without a complete search of nearly the whole field of patent art, which was impracticable. In the following review we have, therefore, confined ourselves mostly to those patents which in effect are designated as variable speed mechanisms as such, hence such devices which are incorporated as incidental features of other inventions have been generally ignored.

One of the first United States patents, if not the first, on variable speed mechanisms is that of J. Kello, April 1, 1815. He was granted a patent for "machinery to produce uniform motion by varying and irregular power." A few other scattered devices of this nature are the subject of patent record, and in 1855 J. T. Heacock patented a power metal drilling machine having a variable speed feed device consisting of cone pulleys in conjunction with a screw by which differential motion of the nut and the shaft was obtained. In this device, Fig. 11, power is transmitted from cone pulley G to the drill spindle through the spur gears H and E. The opposite end of the step cone pulley shaft is belted to the cone S, which in turn is belted to the cone P. This cone contains a nut mounted

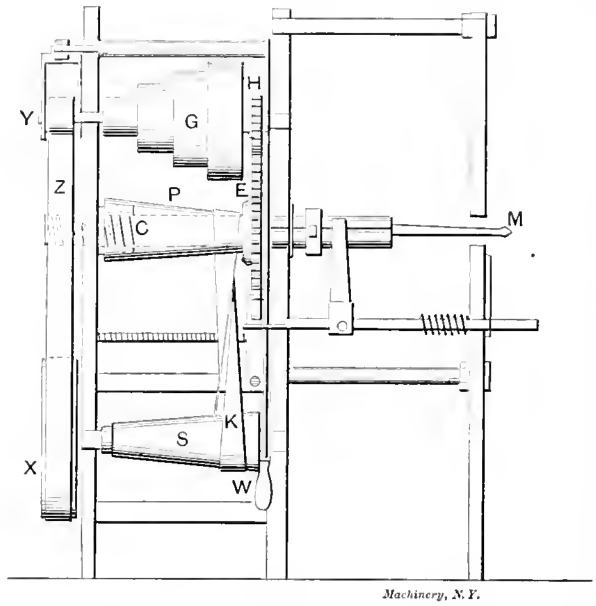


Fig. 11. Variable Speed Feed Device No. 13,845, by J. T. Heacock, 1855.

upon the threaded end of the drill spindle. The drill spindle and the cone pulley turn in the same direction, and of course if their angular motion is equal, there will be no movement of the nut upon the screw. By varying the position of the belt K upon the two cone pulleys, a differential action was introduced by which the drill spindle was given a feed proportionate to the difference in motion of the pulley P and the spindle. It will be noted that the belt connecting the cone pulleys is twisted, which tends to equalize the stresses and prevent climbing.

J. A. Stoddard's device for changing speed, patented May 24, 1859, No. 24,159, covered a broad range in the claim. In his patent he claimed, as new (sic) means for graduating or varying speed by means of pulleys, or their equivalents, operated in connection with surface wheels or their equivalents in such

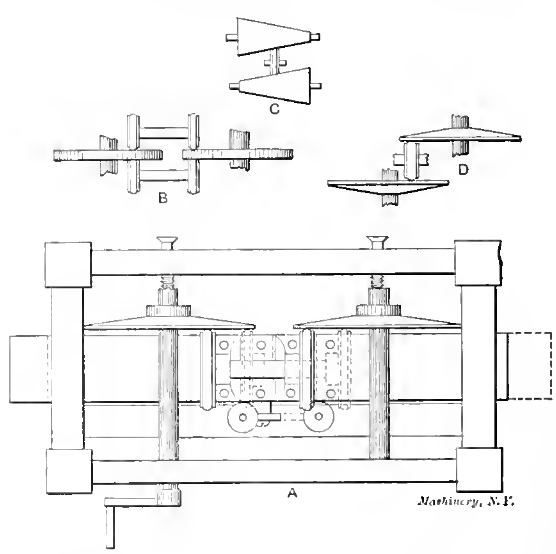


Fig. 12. Patent No. 24,159 of J. A. Stoddard, for Changing Speed, 1859.

a manner as to receive and transmit the motion at variable distances from their centers. It will be observed from the drawings, group Fig. 12, that his invention is not the simple friction and disk wheel, or one cone and friction wheel, but a combination of two such elements, whereby the speed-varying capacity is practically doubled.

In group Fig. 13 we have the well-known Sellers' patent, variable speed feed-device for lathes and other machine tools.

This was patented by Coleman Sellers, September 10, 1861, No. 33,283, and assigned to William Sellers & Co. In his patent specification, Mr. Sellers outlined the object of his invention as being to improve the transmission of motion by frictional contact, so as first, to insure the duration of the surfaces in contact, and to compensate for the inequalities arising from wear or inaccuracy of workmanship without affecting the position of the centers of rotation; second, to furnish a ready

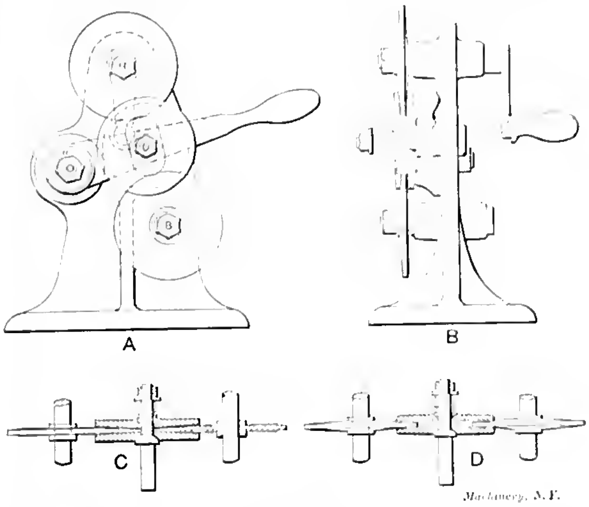


Fig. 13. Variable Speed Feed Device, Patented by Coleman Sellers, 1861, No. 33,283.

means of changing the velocity of the driver and driven; and third, to prevent the strain on the journals being increased much if any, over that due to the power transmitted, as in ordinary cog gearing. He criticised a belt as being objectionable for feed devices on lathes and other machine tools because of the necessarily short lengths between centers. The belt either had to be stretched so that its elasticity was destroyed, or an idler pulley had to be introduced so as to take up the slack; moreover, a short belt produced heavy pressure on the journals, and the third object of his invention was to

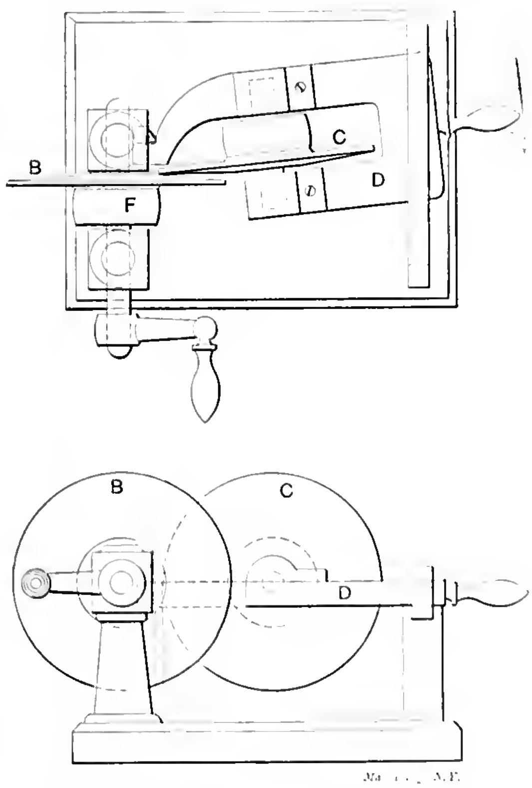


Fig. 14. Patent No. 128,773, granted to L. Wright, 1872.

overcome this. The second object, that of furnishing a ready means of changing the relative velocity of the driver and driven, could be obtained, as he pointed out, by means of the well-known device of two conical pulleys with a belt so arranged as to shift over their various diameters, but he had found this arrangement to be very objectionable in practice, owing to the tendency of the belt to climb up to the highest part of the pulleys, and because of the unequal stretch of the two sides of the belt. He also alluded to plain friction wheels and grooved friction wheel gearing, but said that these are not applicable where a ready change of velocity is desirable. In referring to the friction gearing of the disk and friction wheel type, having the shafts at right angles, he said that this was open to the objection of the plain friction gearing of having limited surfaces in contact, and also that surfaces were in contact which were running at different velocities. The essential features of the Sellers device are two

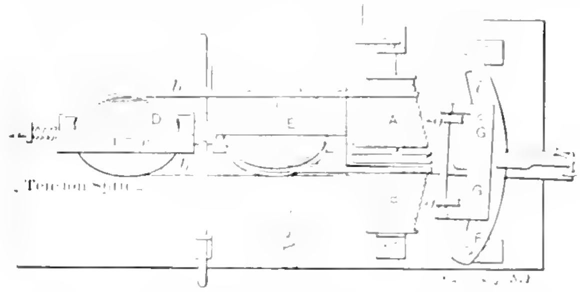


Fig 15 W. H. Wilson's Patent No. 140,751, issued in 1873

disk wheels at a fixed center distance, connected by intermediate clamping disks, whose position can be varied at will. When the clamping disks are in the middle position, the velocity ratio of the driver to the driven is as 1 to 1, and the ratio varies proportionately as the clamping disks are shifted toward either the driver or the driven. In some respects the Sellers device is perhaps one of the best modes of transmitting variable motion, especially for light powers. When the disks are properly shaped, the grinding action is reduced to a minimum. Unfortunately, however, it is limited in power carrying capacity, hence is not considered an acceptable device for transmitting large powers.

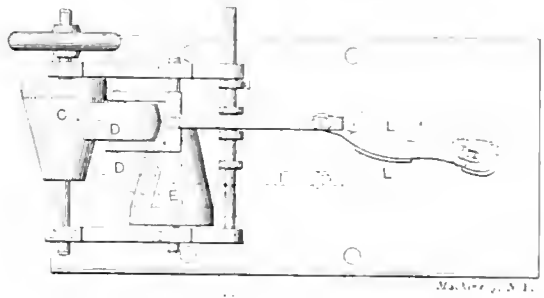


Fig. 16. Patent No. 142,504, issued to L. H. Olmsted, 1873

Patent No. 128,773, granted to L. Wright, July 9, 1872, utilizes two wheels having spherical surfaces which may be brought in contact at various radial distances by swinging one wheel and its frame upon a pivot. In the position shown in the upper view of Fig. 14, the velocity ratio of the driver to the driven wheel is at the maximum. By swinging frame *D* in the direction indicated by the arrow, a larger diameter of wheel *B* is brought into contact with a smaller diameter of wheel *C*, hence the velocity ratio is increased proportionately to the radial distances of the surfaces in contact.

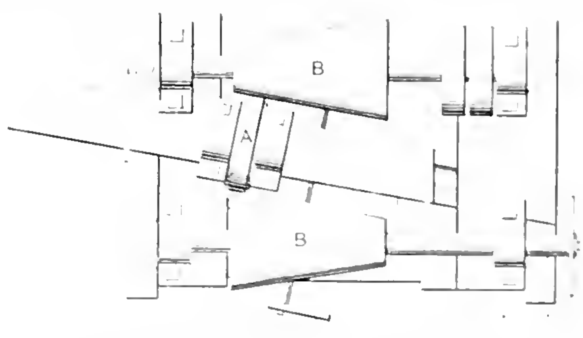


Fig 17 Patent No 148,066, granted to J. D. Husbands Jr. 1874 for Improvement in Gearing of Stone Sawing Machines

In patent No. 140,751, granted to W. H. Wilson, July 8, 1873, motion is transmitted from one stepped cone pulley *A* to another *B*, having a coincident axis by means of a belt *b* running over idler pulleys *D* and *C*, Fig. 15. The inventor also claimed the alternative plan of transmitting motion from one cone to

the other by means of the friction wheels g and g', mounted in a frame G, which was arranged so that the two friction wheels could be brought in contact with the various steps of the cone from the largest to the smallest.

The device shown in Fig. 16 represents the invention of L. H. Olmsted, who was granted a patent, No. 142,504, Sept. 2, 1873. It consists essentially of two cone pulleys C and E, and a double-cone friction wheel D, with provision for varying the position of the friction wheel upon the cone pulleys by means of the foot piece L. It is obvious that the construction shown must be productive of much loss of power, inasmuch as the friction wheel is tapered to correspond to the taper of the cone, but the taper is in the opposite direction, hence all surfaces in contact, save those in the medial plane, are running at dif-

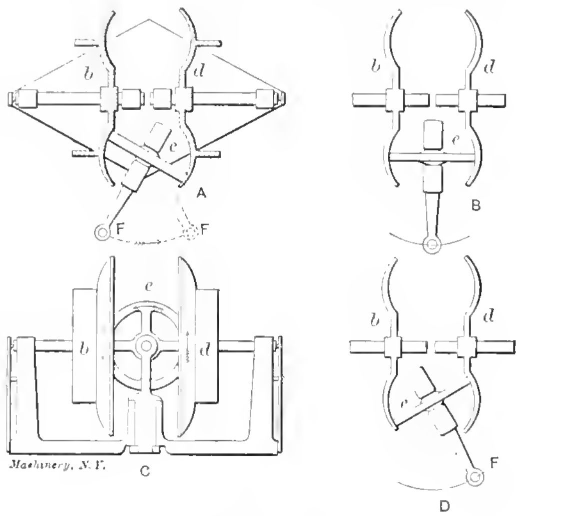


Fig. 18. Patent No. 197,472, granted to C. W. Hunt, 1877, for Variable Speed Countershaft.

ferent velocities. This, it may be remarked, is the one great failing of almost all friction contact devices, and is largely the cause of their want of durability. The mere matter of transmitting power by the friction wheel is not so severe as the grinding action that is inevitable when surfaces are in contact which do not or cannot travel at the same rate.

In Fig. 17 the patent No. 148,066, granted to J. D. Husbands, Jr., March 3, 1874, for improvement in the gearing of stone-sawing machines, is of a more practical nature. In this the

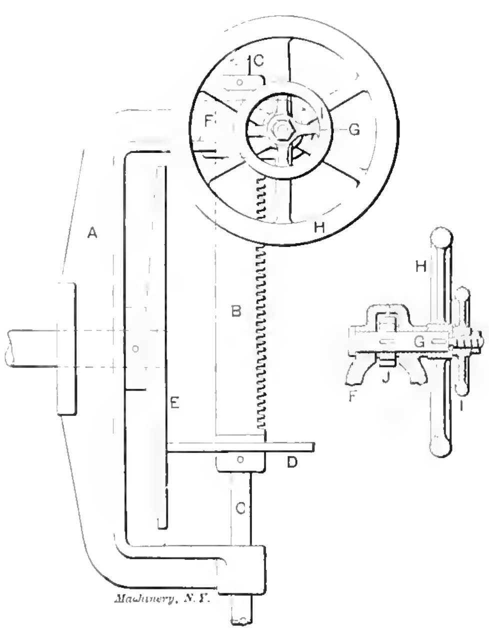


Fig. 19. Patent No. 258,533, granted A. Gordon and T. Reiss, 1882.

friction wheel A is made cylindrical in shape, hence the difference in movement of surfaces in contact with the cones, is not as great proportionally as in the previous device, just described.

On November 27, 1877, C. W. Hunt was granted patent No. 197,472 for the variable speed countershaft, group Fig. 18. It consists of two disks b and d, which are made with grooves, a cross section of which is the arc of a circle. These disks embrace between them within the torus thus formed the friction wheel c. The angular position of this wheel determines the velocity ratio between the driving and driven disks. This idea has been the subject of numerous later patents.

In Fig. 19 we have the well-known variable feed device, largely used on the machine tools built by the Niles Tool Works, for which patent No. 258,533 was granted to A. Gordon and G. T. Reiss, May 3, 1882. The construction is obvious from the drawing. The principal element of novelty is the means pro-

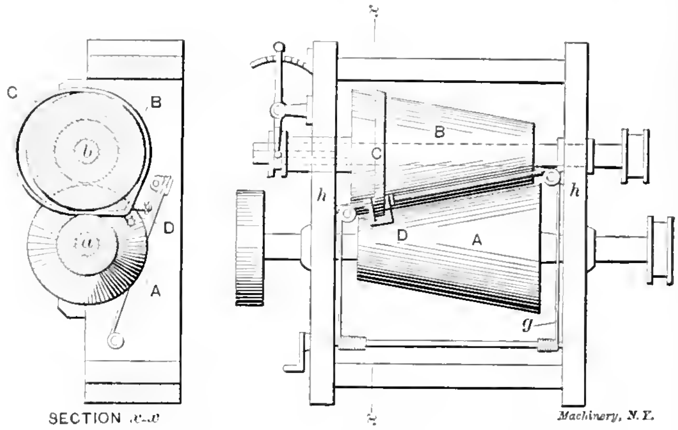


Fig. 20. Device Patented in 1884 by W. E. Laird, as No. 299,231.

vided for shifting the friction wheel D across the face of the disk wheel E. The hand wheel H, carrying the pinion J, meshes in the tubular rack B, and this provides means for controlling the position of D. Small wheel I is for locking the hand wheel pinion in any desired position.

In Fig. 20 patent No. 299,231, granted to W. E. Laird, May 27, 1884, we have two opposing cone pulleys, A and B, mounted closely together, but actual contact is made through the belt or band C, hence the longitudinal position of this band deter-

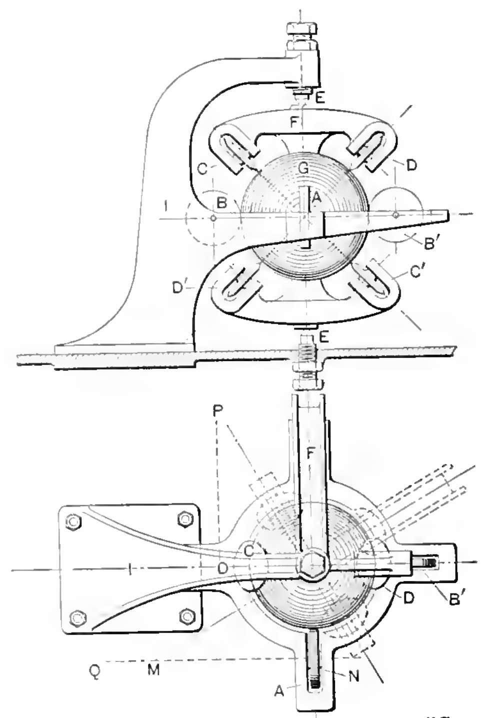


Fig. 21. Patent No. 312,171, H. S. Hele Shaw, 1885.

mines the surface of cones A and B, which are in virtual contact, and thus the velocity ratio is changed by shifting C from one end to the other of the cone B.

The device shown in Fig. 21 was granted to H. S. Hele Shaw, Feb. 10, 1885, No. 312,171, and is designated as an "apparatus, whereby the relative motion of two or more bodies may be varied in any required manner, independently of their actual motion." This interesting device patented by Mr. Shaw, is described at length in his specification, which is illustrated with twelve drawings. Fig. 21 represents the more general form of the arrangement of the mechanisms. It consists of a sphere G held in position by friction wheels C, C', D, and D'. A friction wheel A is supposed to be the driver and B the

driven. The position of the frame F determines the actual velocity ratio of the driver and driven wheels. In the positions shown by the full lines it is obvious that the friction wheel B would receive virtually no motion whatever from the motion of sphere G when transmitted by A. By shifting the position of the frame F to that indicated by the dotted line, more and more motion is given to B, depending upon the angle of displacement, and as the frame is shifted to an angle of 90 degrees from that it formerly occupied, it is claimed that the conditions existing in the first place are completely reversed, or in other words wheel B would have an infinite motion to that of A.

* * *

AUTOMATIC TWIST DRILL GRINDING MACHINE.*

The machine described in the article here abstracted is manufactured by Frederic Schmaltz, of Paris. It is shown in half-tone in Fig. 1.

It is well known that it is quite impossible to obtain the best results from twist drills which have been ground by hand, as any deviation from the correctness of center, or difference between the cutting angles of the lips of the drill, ruins the truth of the hole and imposes considerable stress on the drilling machine. To get the best results out of twist drills two chief conditions must be fulfilled, supposing the quality and temper of the steel to be the best. These conditions are, first, that the two cutting edges simultaneously come into contact with the work throughout their whole length. This condition is only fulfilled when the two cutting edges are elements of the same cone. In standard practice the included angle of this cone is 118 degrees. Second, the lip clearance or the backing off of the metal back of the cutting edges should vary with some regularity from the point of the drill where it is greatest to the periphery where it is least acute. The cutting angle of the drill is determined by the amount of this clearance; it varies from 50 to 60 degrees, 59 degrees being the cutting angle most generally employed, although recent experiments with high-speed steel drills would indicate that a somewhat smaller angle would be more advantageous. This has not been adopted into standard practice, however, and where a drill is to be employed for various metals, the angle had best approach 60 degrees, according to our French contemporary.

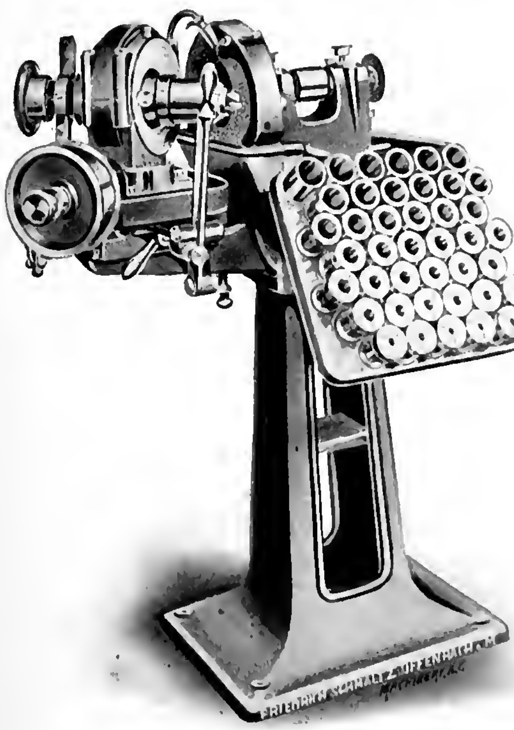
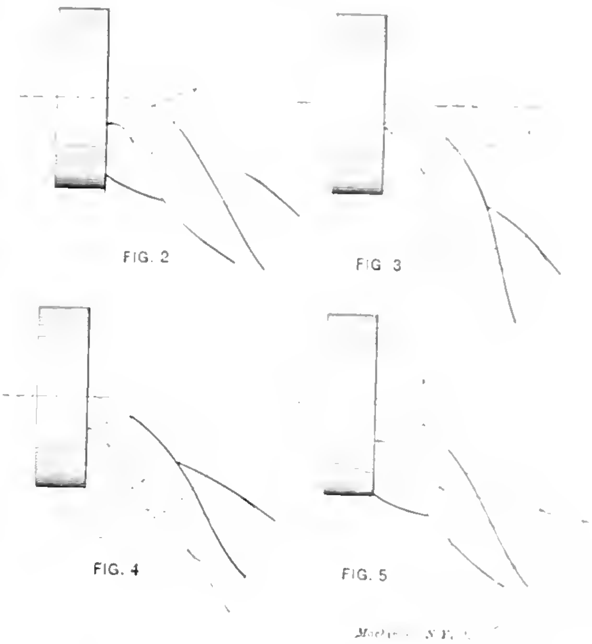


Fig. 1. Schmaltz Twist Drill Grinder.

Four possible methods of grinding the cutting edges of a twist drill are represented diagrammatically in Figs. 2 to 5. Fig. 2 represents a drill being ground on the plane surface of a grinding wheel, the drill being turned about its own axis, thus giving to the extremity of the drill the form of a cone as shown. This construction allows no clearance back of the cutting edges determined by the intersection of the conical surface with the spiral flutes of the drill, and the drill will be terminated by a sharp point, which would not cut. In Fig. 3 the drill is not only turned about its own axis, but at the same time a circular movement around an axis parallel to the face of the grinding wheel is impressed upon it, this motion producing a certain clearance back of the lips. This clearance will, however, be the same from the point of the drill to the periphery, and as according to all authorities the clearance should vary from the point to the outside circumference, this will not do. In Fig. 4, which is a construction commonly used in American grinding machines, the drill is given a conical movement around an axis somewhat oblique to the axis of the drill, as shown. The apex of the cone is above the point of the drill, and the cutting edges of the drill are elements of this cone. In this construction a clearance is generated, which increases uniformly from the periphery to the point of the drill.



Figs 2 to 5. Possible Methods of Grinding Twist Drills

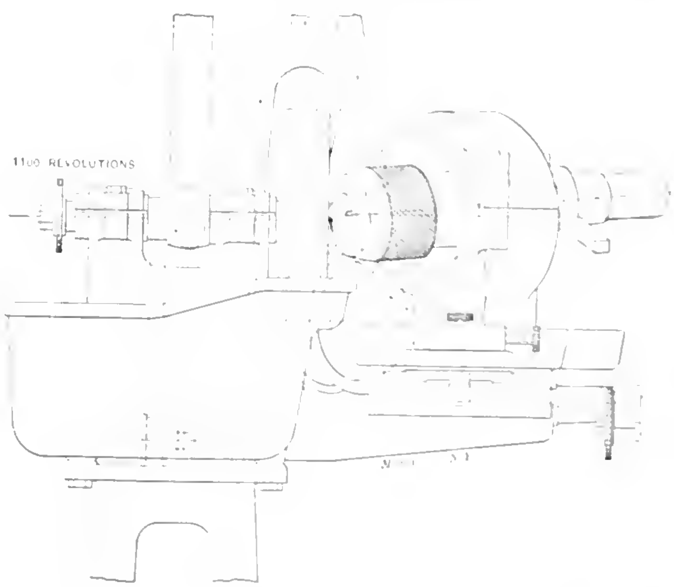


Fig 6 Side Elevation of the Schmaltz Grinder Broken Away showing Arrangement of Belting

In Fig. 5, which is the construction used in the machine about to be illustrated, the cone described has its apex behind the point of the drill. This construction apparently gives very much the same sort of variable clearance as that given by the construction in Fig. 4. The variation in clearance does not seem to be as great from the point to the periphery, but, on

* Portefeuille Economique des Machines, March, 1905.

the other hand, the clearance of a drill should not be excessive at the point or it will cut too rank. According to the *Portefeuille Economique*, the grinding with this inverted cone construction is done by the wheel cutting the cone close to its apex, giving a pronounced clearance with the least angle of opening of the cone.

After this introduction, it may be said that the automatic machine in question, as shown in detail in Figs. 6 to 11, carries a grinding wheel mounted on a belt-driven spindle which

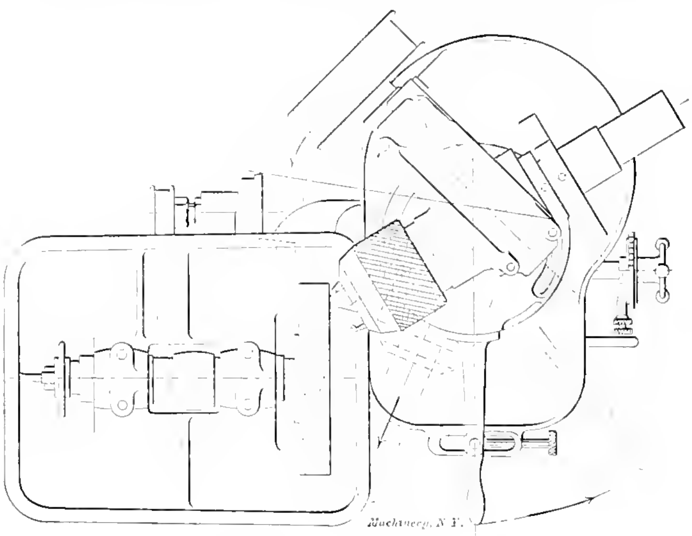
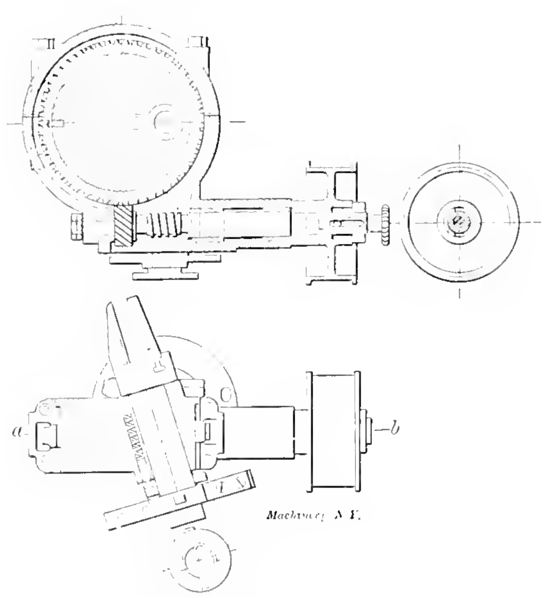


Fig. 7. Plan View of the Grinder.

is given 1,100 revolutions per minute. A belt-driven pump is provided, for cooling the wheel and drill. The drill to be ground is mounted upon a carriage, which also is operated by an independent belt from the countershaft.

The drill is given four movements, of which three are simultaneous and continuous, and the fourth is produced periodically at each half turn. These movements are, first, a continuous conical revolution as described above, in which the drill to be ground is brought against the face of the grinding wheel; second, a periodical rotation of the drill about its own axis. This is so arranged that the drill turns about its own axis as many times in the course of one complete rotation about the axis of the cone as there are cutting edges to be ground, so that each lip is successively brought in contact

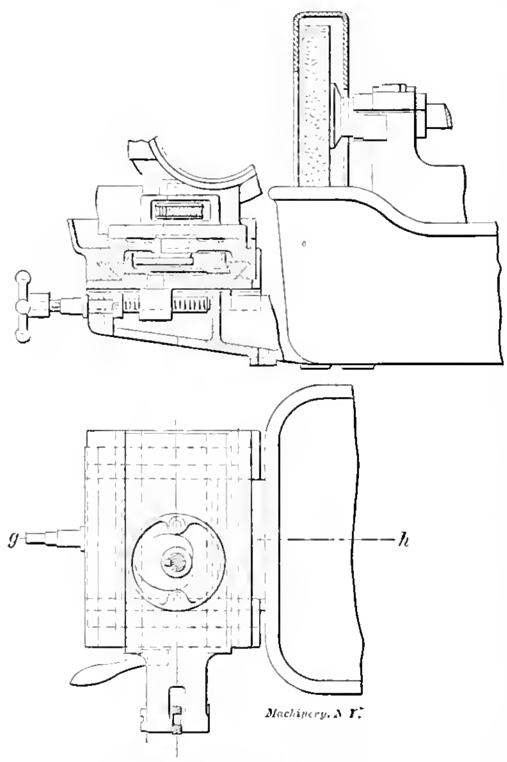


Figs. 8 and 9. Fig. 8, Longitudinal Section on line a—b, Fig 9. Fig. 9, Plan and Horizontal Section through Drill-carrying Socket.

with the face of the grinding wheel. Third, a back and forth movement of the carriage carrying the drill, parallel to the face of the grinding wheel, so that the grinding is equally distributed over the whole face of the wheel, and the latter is thus equally worn. Fourth, a feed motion perpendicular to the face of the grinding wheel.

All these movements are derived from the belt-driven pulley shown on the carriage. The spindle carrying this pulley turns a disk, as shown in Fig. 8, by spiral gearing. In this disk is placed the socket carrying the drill to be ground, obliquely to the axis of the disk. As the disk revolves, a cone is described like that indicated in Fig. 5. This is the first movement mentioned above. For the second, the drill-carrying socket is provided with a lever, back of the disk, which lever encounters, each revolution, a finger fixed in the cap of the disk. The socket is thus obliged to turn about its own axis. This lever is double, as shown in Figs. 7 and 9, for a twist drill having two edges, triple for a three-lip drill, etc., so that the cutting edges of a drill are all equally ground, each revolution of the disk.

For the cross motion of the carrriage a horizontal worm-wheel meshes with a worm carried on the pulley spindle, as shown in Figs. 8 and 10. A cam fixed to the arbor of the worm wheel produces the cross motion of the carriage by its action on oppositely disposed rollers carried by the cross slide as shown in Figs. 10 and 11. The fourth, or feed, movement, is obtained automatically through the agency of a pawl and ratchet, actuated by the cross movement of the carriage. The drill may be fed into the wheel by hand, through the hand



Figs. 10 and 11. Fig. 11, Plan View of Carriage, and Fig. 10, Elevation and Section on Line g—h, Fig. 11.

wheel shown in Figs. 6 and 10, after the automatic feed has been thrown out by lifting the catch. To replace the drill after grinding by a new one, the carriage is revolved about a pivot by means of the hand lever shown in Fig. 7. When the drill comes into the position shown in dotted lines, it may be easily removed.

The drill was held in place on the first machine built of this type by a sort of chucking device, in which, at first, three holding lugs were used. To obtain a better centering of the point, this was replaced successively by chucks carrying four and then six lugs, a better centering being obtained by each. It was finally determined that the most precise centering was to be obtained by means of split bushings, bored to the diameter of the drill. The machine is at present furnished with a series of such bushings, having diameters varying by millimeters. These bushings are shown in Fig. 1, carried in a stand which is arranged for them on the side of the machine. In operation the proper bushing is forced into place round the drill, when it is easily tightened about the drill by the knurled nut shown. By this method drills are quickly and exactly centered, and easily replaced.

In grinding, the drill is presented to the grinding wheel at the angle previously determined, usually 59 degrees. During each rotation the drill turns about its axis twice through an angle of 180 degrees, if a double twist drill, or three times

through 120 degrees if it has three cutting edges, and successively presents each of these cutting edges to be ground. By this automatic arrangement, the lips are certain to be of exactly the same length. The grinding wheel is covered by a casing to prevent the spattering of water. Part of this casing is hinged, and may be lifted in case it is desired to grind a piece of work on the edge of the wheel. A small thin grinding wheel having rounded edges is carried on the rear of the grinding wheel spindle for the purpose of reducing the thickness of the web of a drill between the cutting edges, when this has become too great. This is common to most drill grinding machines and is necessary because the flutes of a drill become more shallow as they approach the shank to increase the strength. Hence, after a drill has been ground a number of times, the web between the cutting edges becomes too thick.

This apparatus is a wet grinder, an automatic pump taking water from the basin formed by the top of the structure, and throwing it on the lips of the drill being ground. The machine is constructed in four sizes.

* * *

VARIABLE SPEED MOTORS.—12.

THE ELECTRO-DYNAMIC COMPANY'S INTER-POLE VARIBLE SPEED MOTOR.

WM. BAXTER, JR.

The variable speed motor made by the Electro-Dynamic Company, of Bayonne, N. J., is constructed so as to permit wide speed variation, through field regulation, without producing sparking at the commutator brushes. As has been explained in several of the articles of this series, the range of variation obtainable by means of field regulation, in motors of the ordinary design, is limited practically to a ratio of about two to one, owing to the fact that a greater variation causes the brushes to spark to an injurious extent. In the Electro-Dynamic inter pole motor double this range of variation is obtained without producing any visible sparking. The result is accomplished by means of the addition of small poles that are placed intermediate between the regular poles of the motor. The construction can be understood at once from an inspection of the photographic illustration, Fig. 1, which shows the motor field complete, the armature being removed so as to more clearly reveal the position of the inter poles. The coils wound upon these inter poles are connected in series with the armature and as a consequence their magnetizing effect varies with the strength of the armature current. The circuit connections of the motor are clearly shown in the diagram, Fig. 2, in which the outline of the field is shown at the top and the armature is represented by the small circle directly below it.

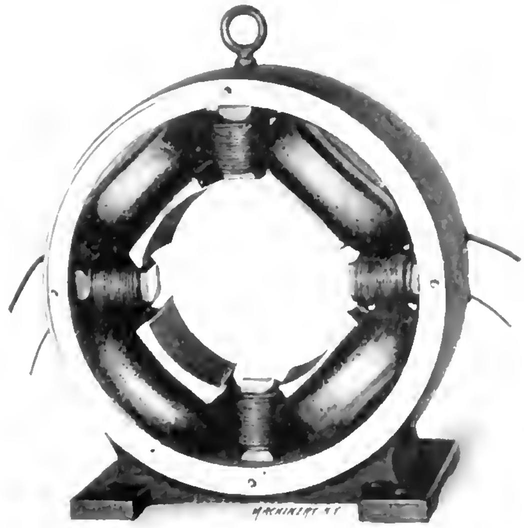


Fig. 1. Motor Field, showing the Inter Poles

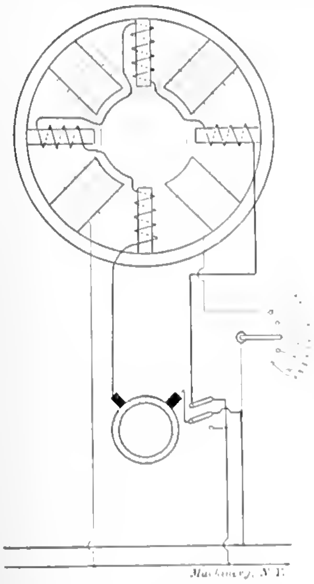


Fig. 2. Circuit Connections of the Motor.

Fig. 3. Diagram showing the Path of the Magnetic Fluxes

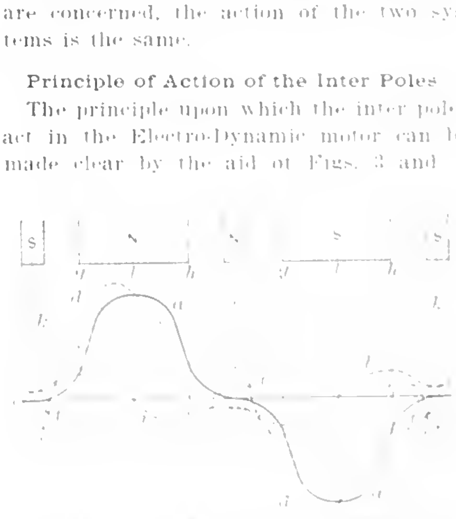


Fig. 4. Curves of Magnetism showing Action of the Inter Poles

The Office of the Inter Poles.

The office of the inter poles is to provide a commutating magnetic field that will increase and decrease in accord with the armature current, and thus prevent sparking at the brushes, and it is for the purpose of attaining this result that the coils are connected in series with the armature.

The first impression an electrical engineer would gain upon inspecting this motor would be that it operates upon the same principle as the Thompson-Ryan motor, made by the Ridgway Dynamo & Engine Company, but such a conclusion is not strictly correct. Both constructions accomplish the same result, but the action in the two is different. In the Thompson-Ryan motor, the balancing coils act to neutralize the armature re-action, and at the same time to develop a commutating field of the proper magnitude to obtain sparkless commutation. In the Electro-Dynamic Company's motor the inter poles act to develop a commutating magnetic field of the proper magnitude to produce sparkless commutation, but do not counteract the distorting effect of armature re-action upon the field magnetism. The distortion of the latter magnetism by the re-action of the armature does not result in any injurious effect upon the action of the motor, that is it does not reduce its capacity, or its efficiency, hence, in so far as practical results are concerned, the action of the two systems is the same.

Principle of Action of the Inter Poles

The principle upon which the inter poles act in the Electro-Dynamic motor can be made clear by the aid of Figs. 3 and 4. In these diagrams we have shown the paths of the several magnetic fluxes when acting alone and also when acting in combination with each other. Fig. 3 shows a portion of the field F and the armature A of the motor. If we assume that the armature is held stationary and the current is passed through the field coils, there being no current traversing the armature, the magnetic flux developed by the field coils will flow in the paths indicated by lines a a a a in the lower half of the diagram. If we shut off the current from the field coils and pass a current through the armature, then this current flowing through the armature coils will develop magnetic fluxes that will flow in the paths

indicated by lines *b b b*. If currents are passed through the field coils and the armature at the same time, the flux developed by the field coils will not be located along the lines *a a a* and that developed by the armature will not be along the lines *b b b b*. Magnetic fluxes will not flow in opposite directions through a magnetic circuit, and they have a decided objection to crossing each other's paths, hence, when the field and armature coils are both traversed by currents, the former

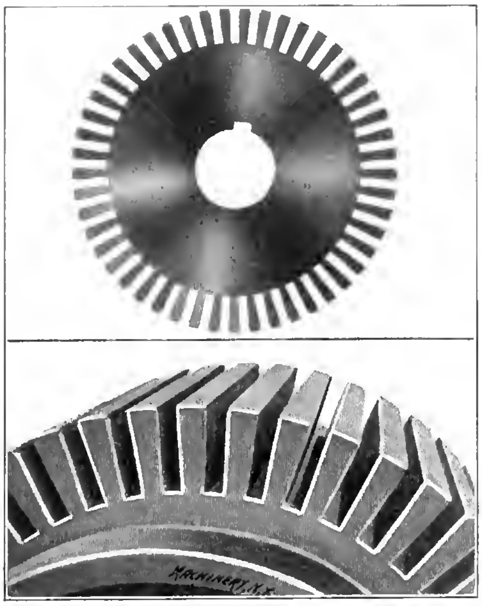
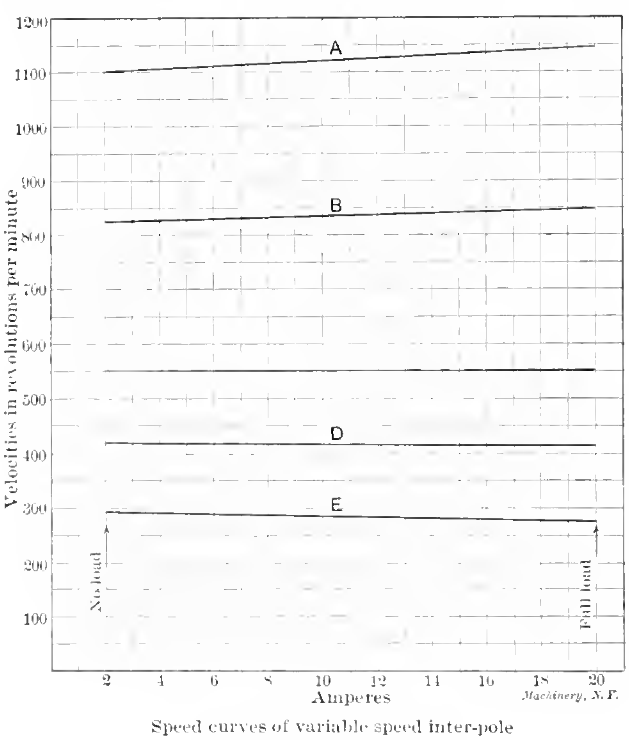


Fig. 5. Portion of Armature Core, showing Deep Slots to hold correspondingly Large Coils.

try to push the latter out of the way, and the latter try to treat the former in the same manner. If the armature and field are traversed by currents flowing in the proper direction to cause the rotation to be clockwise, as indicated by arrow *e*, the re-action of the two magnetic fluxes will result in shifting the field magnetism back to the position indicated by the lines *c c c* in the upper half of the diagram. The greater part



Speed curves of variable speed inter-pole motor at different velocities.
Fig. 6.

of the armature flux will follow this path, although some of it will circulate in the shorter path indicated by curve *g*. The stronger the armature current the greater the displacement of the field flux, so that while a very weak armature current might not cause the lines *c* to deviate much from the position of lines *a a a*, with a sufficiently strong current they could be shifted even further than shown in the diagram.

The Effect of the Armature Flux.

Although the effect of the armature flux is to shift the field flux toward the position of lines *c c c*, all the magnetism is not forced to follow this path; as a matter of fact the magnetic flux will issue from the whole polar surface, all the way around to the edge *f*, unless the armature re-action is enormous. When a motor is running under practical conditions, the displacement of the flux is not sufficient to drive it away from edge *f*, in fact some of the flux will pass to the armature even beyond this point, forming what is called the commutating fringe. In motors of the common type, the commutator brushes are set so as to short circuit the armature coils as they pass a point slightly in advance of *f*, for example on the line *x*, and the strength of the magnetic field at this point is sufficient to perform the operation of commutating the current effectually, that is, for a given strength of armature current. If the armature current increases, the field flux is driven further in the direction of lines *c c c* and the flux at line *x* becomes weaker, when it should be stronger to effect perfect commutation. If the armature current is reduced the result will be just the opposite, the flux at *x* will be increased, when it should be reduced.

Path of the Inter-pole Flux and its Commutating Action.

In the Electro-Dynamic motor, the inter pole *N′* develops a flux that follows the path *d*, a very small portion of it probably takes the path *i* from the end of the pole pasing around path *g* to join *c*. This flux being developed by the same cur-

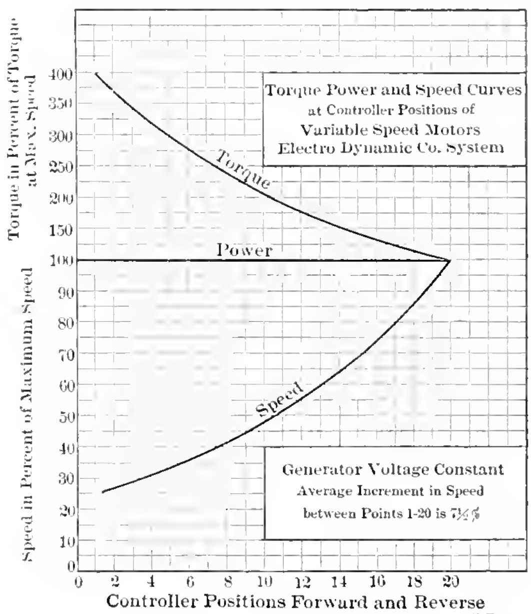


Fig. 7. Torque and Velocity Curves for Different Loads.

rent that passes through the armature increases and decreases in accord with this current and as a result it is the proper kind of a flux to perform the act of commutation. If the commutator brushes are set so that the short circuited armature coils are directly under the center of *N′*, the commutation will be perfect for all strengths of armature current because the flux of *N′* will be weak when the armature current is weak, and strong when the armature current is strong. Without going into a complete dessertation on the subject of commutation it is not possible to make perfectly clear the reasons why the magnetic flux of the inter pole *N′* can produce perfect commutation on account of its varying as the armature current varies; but as this subject has been discussed in previous articles of this series it ueed not be treated in this connection any further than to say that to prevent sparking it is necessary that the current flowing in the commutated coil be reduced to zero, and be replaced by a current of like magnitude flowing in the opposite direction, while the coil is short-circuited. If the armature current is weak, the act of commutation will consist in stopping a weak current and building up another weak current flowing in the opposite direction, the whole action being accomplished while the commutated coil is short circuited. If the armature current is strong, a strong current must be stopped and an equally strong one must be generated in the commutated coil while this coil is short cir-

cuited. The commutating magnetic flux accomplishes this result by inducing in the commutated coil an electro-motive force, that is opposite in direction to that of the current flowing in the coil at the instant when it is short-circuited, and great enough to stop the current and build up a reverse current to the same strength by the time when the short circuit of the coil is broken. The stronger the armature current, the greater the electro-motive force required to be induced in the commutated coil to reverse the current. The magnetic flux of pole N' increases and decreases with the armature current, hence, it will induce in the commutated coil an electromotive force of the proper magnitude for any strength of armature current, assuming of course that N' is properly proportioned.

Fig. 8. Curve of Efficiencies for Various Loads.

As is stated in the foregoing if a motor of the ordinary design has the brushes set so as to short circuit the armature coils when they pass line x, the flux at this point will be too weak for perfect commutation when the armature current is strong, and too strong when the armature current is weak. This is the case with a constant speed motor, but if the armature is made with a small amount of wire on it, so that its reaction upon the field is small, the imperfection in the commutating action will not be sufficient to produce noticeable sparking with any variation in the strength of the armature current that is likely in practice. If, however, the motor is of the variable speed type, then the case will be decidedly different because the variations in velocity are obtained by weakening the field magnetism, and this weakening is not slight, but on the contrary it is great; thus to double the speed the field magnetism is reduced to one half. Now if the field is reduced to one half, it is equivalent to doubling the strength of the armature magnetization so that to obtain a good running motor of the ordinary type with a speed variation of two to one it is necessary to make the armature decidedly weak, and the field correspondingly strong. With the construction of Fig. 3 it can be seen that it makes no difference to what extent the field magnetism is reduced, within reasonable limits, because the act of commutation is performed by the magnetism of the inter pole N' and this is developed by the armature current, hence it will be in proportion to the latter without regard to what the relations between the field magnetism $a\,a\,a$ and the armature magnetism $b\,b\,b$ may be.

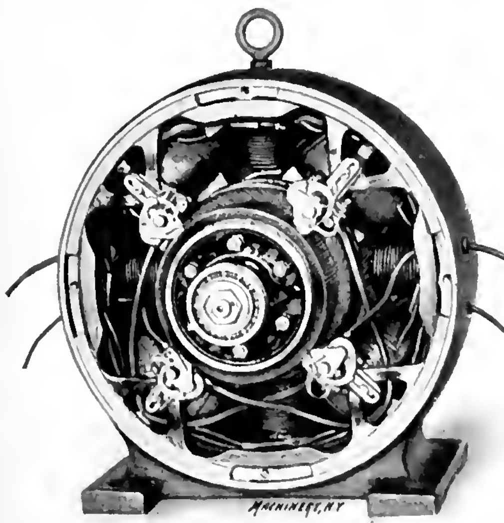


Fig. 9. Motor with Front Frame Removed, showing Ball Bearings

Inter Pole Action Unaffected by Armature Reaction.

That the variation in the strength of the field or the armature magnetism, or both has no effect upon the action of the inter pole N' can be made clear by means of Fig. 4. In this diagram, the shaded outlines at the top represent the poles of the motor, the large ones being the main poles and the small ones the inter poles. Curve $a\ a$ represents the field magnetism when there is no current flowing through the armature coils. Curve $b\ b$ represents the armature magnetism when there is no current passing through the field coils. Curves c represent the magnetism of the inter poles. Curve $d\ d$ represents the actual magnetism of the motor when running, with current in the armature and field, and the curves $f\ f$ represent the commutating field produced by the action of the inter poles.

The field magnetism curve $a\,a$ is shown high under the poles because at this point it is strong owing to the fact that the greater part of the flux follows this path on account of the greatly reduced magnetic reluctance. As a matter of fact, in a well-designed motor, the strength of the magnetic field between the poles is much less than is indicated by curve $a\,a$ and under the poles it is more uniform, so that to be strictly correct, the curve under the poles should be flatter, and in the interpolar spaces it should be lower; but the shape shown will serve to illustrate the actions better.

Fig 10 External Appearance of the Inter-pole Motor.

The armature magnetism is shown as stronger under the edges of the poles than at any other points because such it really is, owing to the fact that all the flux that passes beyond the poles and cuts through the interpolar space has to traverse a long air path, as can easily be seen by noting the length of air path of the lines $b\,b$ in Fig. 3.

The curve $d\,d$ is obtained by simply adding curves $a\,a$ and $b\,b$. As will be noticed, this curve, which represents the actual magnetization of the motor, passes to the opposite side of the line $x\,x$ just beyond the front edge of the main poles. This is due to the distorting effect of the armature magnetization. If the inter poles were not provided the brushes, if placed ahead of h, that is, in the position of line x in Fig. 3, would not work well at all, because the commutating action would be just the reverse of what is required; that is, the current in the commutated coils instead of being reversed, would be kept flowing in the same direction and would be increased in strength. To obtain proper commutation with a field dis-

torted as much as shown in Fig. 4, the line x would have to be shifted back of the edge h of the pole.

The inter-pole magnetism e will produce a commutating flux f of practically the same magnitude for any amount of armature re-action when the motor is working within its practical range, owing to the fact that the strength of the armature as well as the field magnetism at the center of the interpolar space, on line k, is very much lower than that under the poles of the machine, hence the changes in it cannot be very great. The reverse magnetization e is produced by the armature flux that circulates in the path g of Fig. 3, together with the small portion i of the inter pole magnetism.

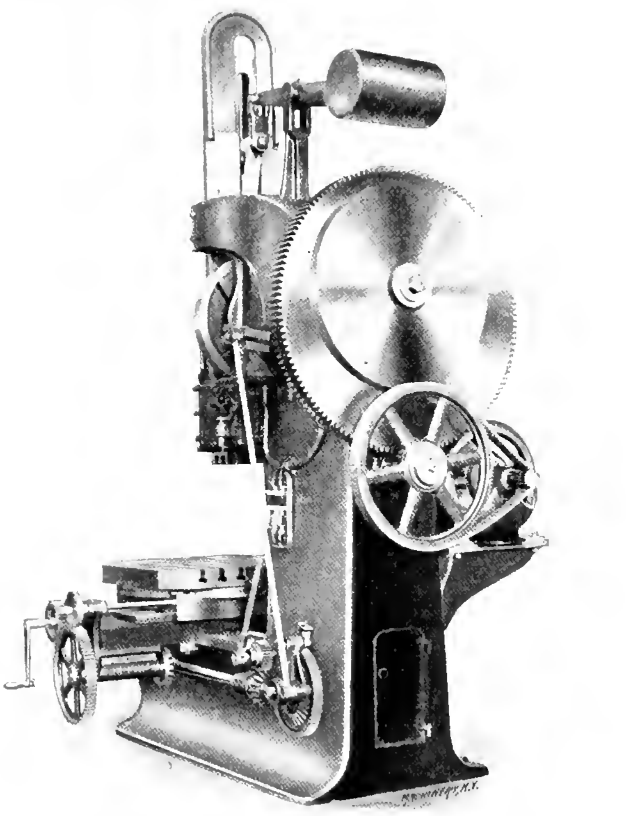


Fig. 11. Twenty-one-inch Bement-Miles Slotter driven by four H. P. Inter-pole Motor; Speed Ratio, 3 to 1.

Owing to the fact that the armature re-action, unless unreasonably great, does not affect the action of the inter poles, the amount of wire wound upon the armature can be much greater than in motors of the ordinary type and in this way the capacity of a machine of a given size can be considerably increased. That advantage is taken of this fact is shown in Fig. 5, which is a photographic illustration of a portion of the armature core of the motor.

Speed Regulating Effect of the Inter Poles.

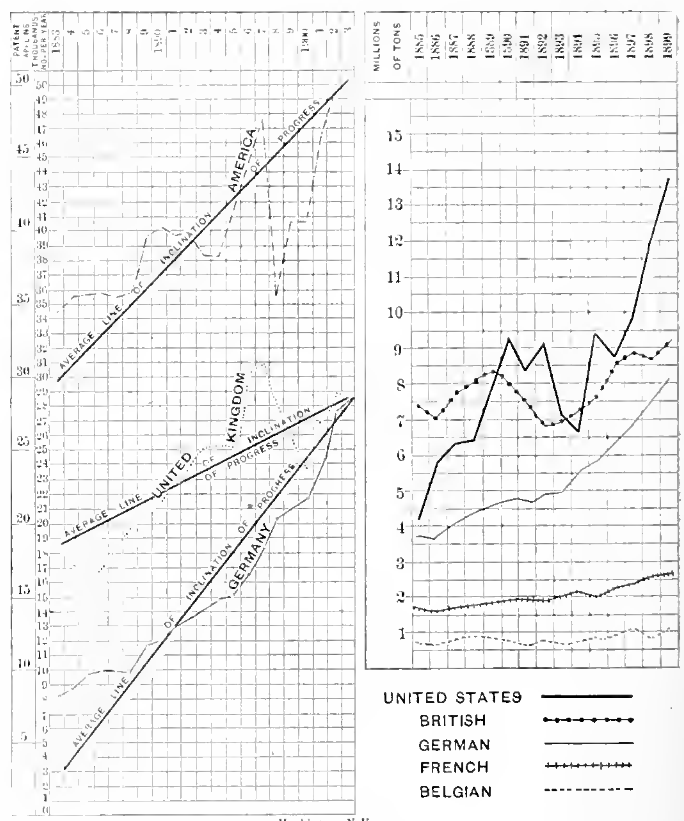
In Fig. 3 it will be noticed that the flux of the inter pole passes out of the armature at h, flowing in the same direction as the field flux, hence it helps the latter to develop the c.e.m.f. The flux entering the armature from N' can be made to neutralize itself, by setting the brushes so that one-half of it cuts through the armature in front of the commutated coil and the other half back of the coil. By shifting the position of the brush, the flux passing from the inter pole into the armature can be made to add to the effect at h or to deduct from it; therefore, by properly setting the brush the assistance given to the field flux in developing the c.e.m.f. can be varied as desired. The result of this is that the motor can be adjusted so that at any given velocity, the speed will remain constant for all loads. For higher velocities, the speed will rise as the load increases, owing to the fact that the e.m.f. developed by the inter-pole flux will increase with the speed; and for lower velocities the speed will drop with increasing load, but not as much as it would if the help of the inter poles were removed. The inter-pole motors are adjusted so that the speed remains constant for all loads when the velocity is about half way between the highest and the lowest. The actual relations for different loads and velocities are shown in the curves A to E of Fig. 6.

The relations between torque and velocity for different loads are shown in Fig. 7 and the efficiencies for all loads within practical limits are given in Fig. 8. The motor is made to run in ball bearings which are clearly shown in Fig. 9, the front frame that holds the bearing in position being removed. Owing to this construction not only is the friction reduced, but the dimension of the motor in the direction of the shaft is considerably reduced. The external appearance of the motor is shown in Fig. 10; it is compact, and small for its capacity, as can be judged from Fig. 11, which shows a 4 H. P. motor with a speed variation of three to one, mounted upon a 21-inch Bement Miles slotter.

* * *

INVENTION IN GREAT BRITAIN, GERMANY AND AMERICA.

In a discussion in the British trade papers concerning the lack of encouragement of the British inventor, as compared with his American and German rivals, the proposition was made by Mr. B. H. Thwaite that the true index of any nation's industrial and commercial position was not that of the axiom of Disraeli—the state of the chemical industry—but the condition of the iron and steel industry. Mr. Thwaite thought there was also another index almost as valuable, namely, the degree of activity of a nation's inventive faculty, represented by the numerical proportion of applicants for patents. The



Charts showing Comparative Inventive Activity and Production of Pig Iron.

charts here given, prepared by Mr. Thwaite, show the progress of inventive activity in America, the United Kingdom, and Germany during the twenty years ending 1903, and the comparative progress of the five great iron producing countries in the production of pig iron from 1885 to 1899. From the former it will be seen that the rate of increase of inventive activity of Germany has been slightly more rapid than that of the United States, with Great Britain left some distance in the rear. The attitude of the British patent office is one to discourage many inventors. For instance, under recent legislation the British inventor is compelled to sub-divide his claims so as to cause him to apply for a number of patents in place of one. Taking out patents is a very expensive matter in Great Britain, and it is claimed by many that the cost under the new act referred to will be greatly increased. Moreover, the granting of a British patent does not even now insure validity. The German inventor, on the other hand, is stimulated to enterprise by the German Mercantile Banking system, by which selected inventions of promise are developed and commercially introduced under the best conditions to secure success.

SHOP TRAINING FOR MECHANICAL ENGINEERING.

DESCRIPTION OF THE COURSE IN SHOP WORK AT THE WORCESTER POLYTECHNIC INSTITUTE.

HOWARD P. FAIRFIELD

The great interest manifested in the shop education of a student in engineering gives evidence of the need for such a training. That this should be a broad rather than a special training seems to be the opinion of all employers, and of men of experience in this line of engineering. This is so generally the fact that the few who hold the opposite view are hardly in evidence. The majority of technical colleges or schools

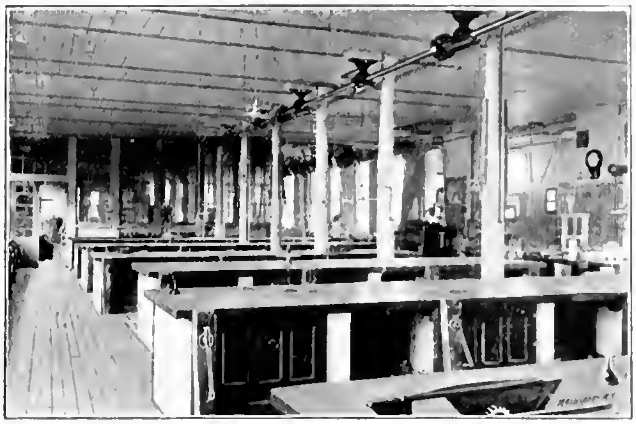


Fig. 1. Work Benches in the Pattern Shop.

recognize this need and provide for it by developing some sort of a shop course. These shops, however, seldom reach the really effective point in instruction because of the necessary expense for equipment. The cost of purchasing new and up-to-date tools and machines makes it expensive to give instruction in modern methods, and on this account the shop course in most colleges of engineering, falls far below the degree of importance which it deserves.

The shop training at the Worcester Polytechnic Institute is in its methods noted for two things, (*a*) the broad and comprehensive grasp of the needs of an engineering graduate, and (*b*) the necessity for keeping up to date in shop management and methods. The shops are made so far as the student is concerned strictly educational. They are an integral part of the department of mechanical engineering, the professor of mechanical engineering being also director of the shops.

Fig. 2. Another View in the Pattern Shop.

The shops are also run as a manufacturing concern employing a number of machinists, molders, and pattern makers. To successfully and economically produce and market a line of machinery requires a modern shop and equipment. A modern system of cost accounting and methods of production must obtain, and all the various costs and operation from the patterns to the selling of the finished machines must make up a systematic whole. It is on this basis that the shops of the Worcester Polytechnic Institute are equipped and run both as a commercial enterprise and as a means to an educational end.

The students are assigned definite hours in these shops, depending entirely upon the engineering course they are taking; that is to say, whether they are fitting themselves for mechanical, electrical, or civil engineering. The students in mechanical engineering get the most extended shop course. The training of the students in the shops is in charge of instructors in mechanical engineering, and as such they are responsible to the head of the department. Four instructors are provided and their business is to teach and help the student in acquiring the broadest and most complete knowledge that the instructor can give during the time assigned to his special work. The instruction is at all times such as the future engineer will need and not that suited to the mere artisan or workman. All instruction in shop work, methods, and management is called "Shop Practice" and is given in the shops, the shop drafting room, and in the shop office. The whole equipment of the shops is at the service of the instructors, the offices as well as the work rooms, and are all and severally used as required. The needs of the student are studied, and as far as it is possible he is provided with the necessary training to fit him for his work as an engineer.

The complete shop course in mechanical engineering is about fourteen hundred hours, and of this amount one-half is at the disposal of the instructor in machine construction. Five hundred and forty hours of the total time is called "Summer Practice" and is given during the month of June, one hundred and eighty hours in each of the first three years. This summer practice is continuous work, ten hours per day until completed, and is common to all the institute courses. For students taking the course in civil engineering it means field work, and for those taking the course in chemistry, chemical laboratory.

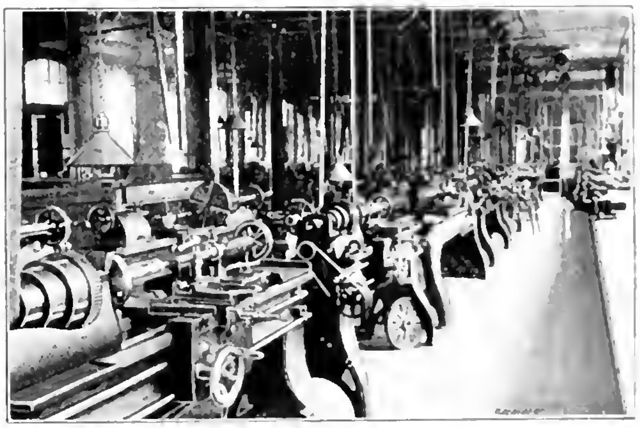


Fig. 3. The Lathe Department in the Machine Shop

The views here shown give some idea of the extent of the floor space provided in the shops and the means at hand for training the students. Figs. 1 and 2 are views in the pattern shop. All first-year students receive instruction in pattern making throughout the year, this work being common to all the courses.

Figs. 3-4-5 are views in the machine shop. Students in the mechanical, electrical, and civil engineering courses receive instruction in this department in varying amounts, according to the course they are pursuing.

Fig. 6 is a view of the forge room, and Figs. 7 and 8 are views in the foundry. The mechanical, electrical, and civil engineering students also receive instruction in these branches.

As already mentioned, the work in pattern making is common to all students since the selection of courses is not made until the end of the freshman year. During the sophomore year the electrical engineering students receive shop instruction during both terms and the sophomore summer practice. The civil engineering students receive shop instruction during a portion only of the sophomore year. For students in mechanical engineering the shop practice forms a part of each of the four years of the course.

The freshman, or first year work, is designed to train the student in the principles of pattern making, the work beginning with the simpler forms of patterns and advancing as rapidly as the ability of the student warrants.

While most colleges believe it is necessary to give the stu-

dent a course in elementary wood work or joinery before commencing his pattern making course, it is not thought advisable to do this at Worcester. If the graduate is to become a teacher of manual training he undoubtedly needs to go through an elementary course in woodwork, but no such training is needed by the future engineer, and thus no time is here given to this work.

Pattern making is first taken up in its relation to the foundry and the questions of draft, shrinkage and allowances for finish are studied. The question of selecting the proper lumber and the method of its use in pattern construction is also included in the elementary pattern making course.

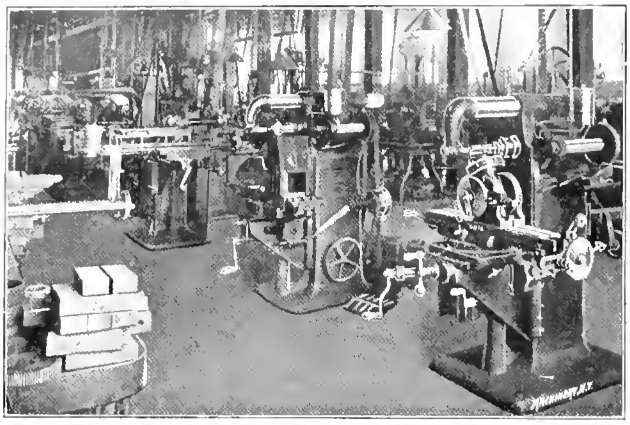


Fig. 4. Machine Shop. Instruction in Milling

The advanced pattern making work includes a study of cored sections and the pattern as a part of a machine. While at work on the above course the student is kept in close touch with the foundry and the machine shop and every point made by the instructor can be checked by actual commercial examples. In the pattern shop all those machines that are common to pattern making establishments are open to the student and pattern costs can thus be made a part of his course.

A short course in foundry work is introduced in the freshman year. This course is used principally as a method of checking his work in pattern making and is a beginning of a thorough course in foundry usages and management.

In all the freshman shop work the student is trained to think for himself and his standing in the classes is regulated to a large extent by his ability to do this. Throughout all the shop training the student is made to understand that as a

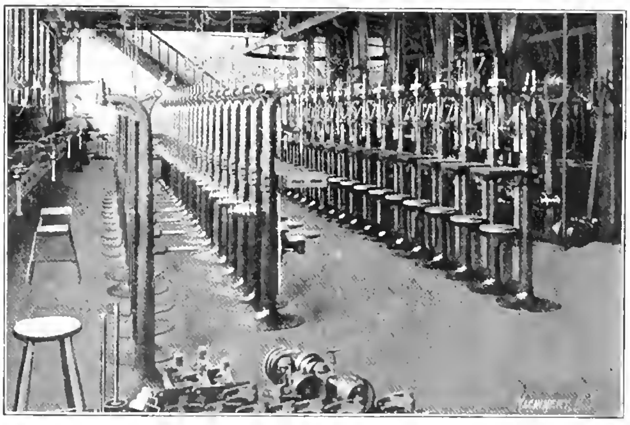


Fig 5. Sensitive Drills, Completed and in Process of Assembling.

graduate engineer he must be able to think and plan not only for himself but for others as well; in fact that he is to become the leader rather than the mere workman.

As in the other branches the foundry is carried on as a business proposition and castings made for outside parties. This adds variety to the work and gives the student an opportunity to take part in the production of work which runs from light machine parts to large charcoal iron castings weighing over two tons.

At the beginning of the sophomore year a start is made in machine practice or metal work. The course as arranged is expected to give the student a knowledge of the use and capacity of all the ordinary machine tools. The students have access to and receive instruction in the use of lathes for both light and heavy work, planers, shapers, milling machines, gear cutters, boring mills, grinding machinery, drilling and chucking machinery and flat turret machines of various makes and sizes; also all the small tools, jigs and fixtures that are necessary for the economical manufacture of a line of light machinery. Instruction in the use of these machines is by lectures and by using the machines themselves. The student is expected to be able to do work on any machine in the shop by the end of his sophomore practice.

During the sophomore year the students start on their forge

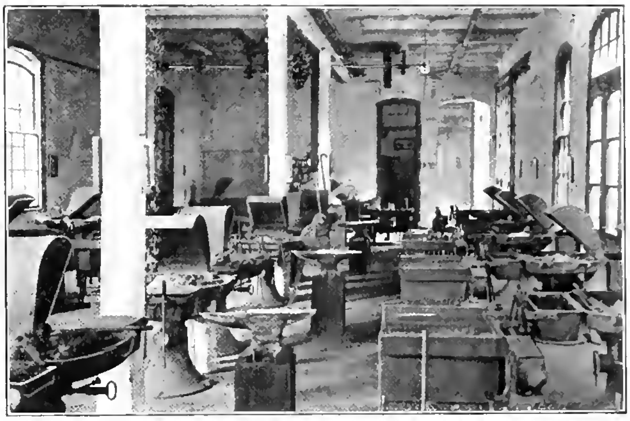


Fig. 6. A View in the Forge Room.

work, which includes the effect of heat on different metals, welding wrought iron and various grades of steel, tempering and annealing, tool making, heat treatment of high-speed steels, work with power hammer and small drop forging.

In the second term the use of high-speed steels is taken up with the classes and the students provide themselves with tool holders for this purpose. A study of cutting speeds, feeds and their effect upon production, is begun at this time, and the student is shown three limiting features of production, (*a*) what the machine will stand, (*b*) what the work will stand, and (*c*) what the tool will stand.

A beginning is also made during this year in the practice of estimating the time necessary to perform work in the different machines used. Upon being assigned a job, the student receives the necessary blue prints and rough stock, and he is required to estimate the necessary time for completing the

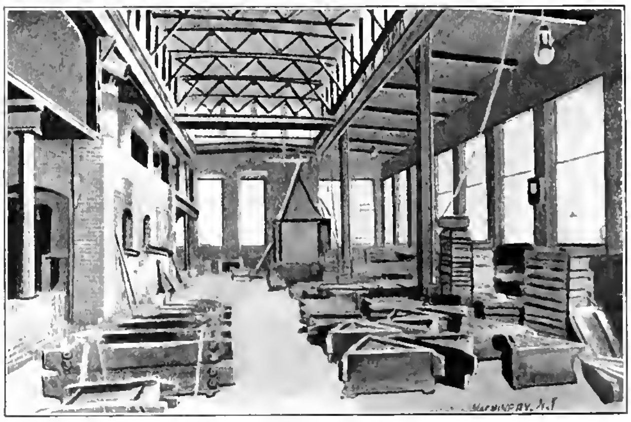


Fig. 7. A Part of the Foundry.

job. The instructor then gives him a card similar to that shown in Fig. 10. This card is retained by the student until the job is completed when it is handed in and stands as a record on the job for that student. On the back of the card the student fills in each day the kind of work done and the time taken, the total of these amounts finally appearing upon the face of the card together with the grade given his work. A complete index is kept and these job cards show at any time the student record, a different color being used for each year of the course. While the estimating of time must at the first be pure guess work it soon ceases to be so and the student is encouraged to keep notes of the speeds and feeds, used in

performing the several jobs, that he may more intelligently estimate the next one. This is in line with the idea that the student is later in his course to take up the study of estimating time of building parts of a machine.

In the foundry the sophomore also has at his command an opportunity to compare costs of molding, coremaking, and the many operations incident to foundry practice. The foundry is line of work the shops build experimental machines for outside parties. This gives the student an opportunity to study the methods of doing work of this kind. He also learns of the increased cost made necessary when building a first or experimental machine over the cost of producing such machines in large numbers, when the jigs and tools have been developed, and the workmen have become skilled in their use.

Operation.	Details of Operation.	Method of Operation.	Machines Used.	Remarks on Setting Up of Machines.	Tools Used.	Speed in R. P. M.	Speed in feet per minute.	Feed per Rev.	Time for Setting Up Machine.	Time for Setting Up Work.	Time for Setting Tool.	Time for Taking Out Work.	Time for Detail of Operations.	Total Time.
Inspecting and Cleaning.	......	......	Emery wheel	......	......	....	.....	....	.	..	..	..	..	27'
Centering.	Prick-punching	Approximate center and test	Lathe (centers)	......	Scratch awl center sq. prick-punch	....	.....	....	.	..	.	..	2 20'	4 18
	Center Drilling	Change work when drilled	Drill Press	......	$\frac{1}{4}$" Drill	....	.....	....	1'	10	.	5'	65'	
	Center Reaming	Change work when reamed	Drill Press	......	60 Reamer	....	.....	....	5'	10	..	5'	22'	
Machining Surface A.	Roughing cut	Change tool after cut	14" N.O.W Lathe	True up Live Center	Large Face Plt. Hook driver, half center H.S.R. Tool	283	100 max.	Hand Feed	5'	15	20	..	20"	1' 36'
	Finishing cut	Change tool after cut	14" N.O.W. Lathe	......	T. S. Side Tool	283	100 max.	$\frac{3}{128}$	..	..	20'	5'	10'	
Machining Surface B.	Roughing cut	Change work after cut	14" N.O.W. Lathe	Remove half-center Line up centers	Full center R. H. offset H.S.R. Tool	283	100	$\frac{1}{64}$	5	15'	15	5	1 5	5' 35
	Dimension cut	Change work after cut	14" N.O.W. Lathe	Line up centers	R. N. offset T. S. D. point	283	100	$\frac{1}{64}$	5	15'	30	5'	1 5'	
	Scraping cut (2 cuts)	Change work after cut	14" N.O.W. Lathe	Line up centers	Lathe Scraping Tool	175	63	$\frac{1}{32}$	5	15'	1	5	2 20'	
Machining Surface C.	Finishing cut	Change work after cut	14" N.O.W. Lathe	......	R.H. offset H.S.R. Tool	175	63	Hand Feed	..	15	20'	5	2	2 20
Machining Surfaces D, E, F.	Roughing cut Surface D	Change tool after rough cut on Surface F			H. S. R. Tool Special Jig	75 47	120 max.		5	15	20	..	5	24 10
	Roughing cut Surface E					47	120	Positive Feed $\frac{3}{64}$	.	..	10	.	1 5	
	Roughing cut Surface F					47	120				10		20	
	Finishing cut Surface D	Change tool after finish cut on Surface F	22" Pond Lathe	......	T. S. R Tool	75 47	120 max.			..	20		5	
	Finishing cut Surface E					47	120	Positive Feed [illegible]			10		1 5	
	Finishing cut Surface F					47	120				10		20	
	Final cut Surface D	Change work after cut			Scraping Tool	25	63 max	Positive Feed [illegible]			40	5'	9	

Total time, 38 26

Fig. 8. Table of Calculations made by Seniors in Estimating Cost of Production of a Machine Part. Totals are on the basis of 50 pieces.

a new, modern, and well lighted building, and is equipped with two cupolas, a large core oven, a travelling crane, molding machines, core making machines, fans, rattlers, etc.

The work of the junior year is largely advanced machine construction, and a study is made of jigs and fixtures and their usefulness in duplicate work. The use of high-speed steels is given further consideration. Besides their regular

In all this work the student is led from one method to another, one step at a time in a regularly advancing course. Each student has the same opportunities as his classmates but is allowed to advance as rapidly as his abilities allow.

The shop work for the first term of the senior year is devoted to a study of methods of cost reduction and cost accounting in the shops. (Fig. 8 illustrates the results of the study

of the cost of production as made upon a machine part by two seniors.) Fifty pieces are taken as delivered by the foundry and are machined complete, ready for the stock room. A comprehensive study is first made of all the machines, tools and fixtures that might be used in making the part, and the piece is then machined in several ways to determine which tools, machines, etc., are best suited to the work. After finishing these preliminary tests, and having settled upon the machines to be used, tests are made to determine the most desirable feed, speed, and depth of cut to use. To find this, several combinations are tried, each being carried to a point where the machine, the work, or the tool, will stand no more. The results of these tests are studied and a decision arrived at for the best and most economical speed, feed, and depth of cut for roughing out the several surfaces. Various methods of finishing the surfaces are then tried and the best one adopted. The order in which the operations should be performed, is next taken up and different arrangements tried and a conclusion drawn. The several conclusions are then discussed by the instructor and students, and when finally decided upon, are tabulated. The time taken to perform the various operations is carefully taken, notes are made of all that occurs in each case, and the results tabulated. Fig. 8 represents the results of the completed tests and the conclusions arrived at. Besides this a full written report illustrated by sketches of operations is also handed in to the instructor, explaining in detail the tabulated figures and reasons for conclusions.

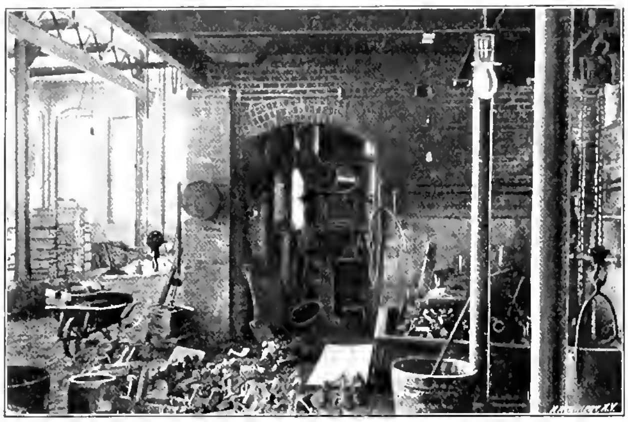
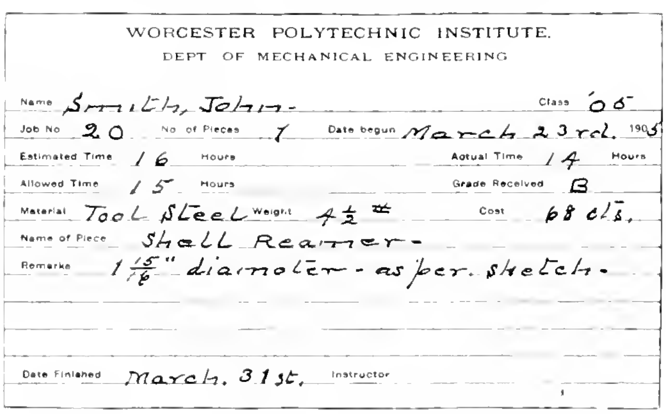


Fig. 9. Another View in the Foundry.



WORCESTER POLYTECHNIC INSTITUTE.
DEPT OF MECHANICAL ENGINEERING

Name Smith, John. Class '05
Job No 20 No. of Pieces 1 Date begun March 23rd. 1905
Estimated Time 16 Hours Actual Time 14 Hours
Allowed Time 15 Hours Grade Received B
Material Tool Steel Weight 4½ # Cost 68 cts.
Name of Piece Shell Reamer.
Remarks 1 15/16" diameter - as per sketch.
Date Finished March. 31st. Instructor

Fig. 10. Sample of Time Card given to Student with each Job.

The class is arranged in groups and turns are taken in timing operations. The tabulated report is studied carefully to determine whether or not some of the operations can not be shortened by improving (a) the tools, (b) the machines, (c) changes in the pattern, (d) methods in the foundry. Any changes that promise even a slight improvement are tried or recommended for trial. Jigs, tools, and fixtures designed by the seniors in this work are built by the junior class and are tried out before being placed in the tool room.

Throughout the entire work of the seniors in cost reduction studies, the student is led into taking the initiative and conclusions are arrived at only after a discussion of the subject by the instructor and students. In other words, the student is supposed to feel that the work is his work and that the instructor is a referee or judge to approve or condemn his results only after a proper discussion of matters has taken place.

The work of the second term of the senior year is taken up with the professor of mechanical engineering, and deals with the questions of shop management from the standpoint of the office man. Opportunities are here given the student to learn methods of superintending, and a study of employment questions is made. As the shops have a weekly payroll of good dimensions the student gets practice in making up such payroll and in the different methods that are employed in keeping the time of employees.

A complete cost sheet for some machine is worked out by each member of the class, the data being taken from the actual time cards given in by the journeymen. Fig. 5 shows a lot of sensitive drills as assembled in the shops. Each and every operation in the production of these machines is known to the student and the costs as worked out by him are the actual shop costs which are kept for each lot for the purpose of comparison and improvement.

A study of the duties of the purchasing agent is made and the different price lists and discount sheets discussed. Methods of keeping track of the work as it passes through the shop are taken up, stock lists made out, systems of billing and methods of foreign and domestic shipment are studied, and the student assisted to make as complete an analysis of office methods of superintendence as his time will allow. Here as in all the shop work taken, the line between the engineer and the workman is never lost sight of either by instructor or student, and the whole training is given with the idea that the graduate is to become a master in his line of work, an employer of men, and a director of enterprises.

The responsibility for attendance rests entirely with the students. While they are expected to be present as assigned for their shop practice, they are not required to be there nor to make up lost time. Each student is given an opportunity to work under an instructor in the shops at regular intervals, and he is marked according to the use he makes of these opportunities. If his average for the term falls below 60, he must repeat the work the following year, or else annul his condition by passing a satisfactory examination.

* * *

Tantalum, the metal that has lately been employed by Siemens & Halske for incandescent lamp filaments, or tantalium, as it is variously called, the difference of usage in the spelling of this word being the same as in the case of aluminum and aluminium, is said to possess remarkable possibilities for tool making. N. von Bolton, a chemist, is said to have shown by laboratory experiment that it is both tough and of a hardness almost equal to that of the diamond. A sheet about .039 inch thick was hammered from the first piece produced of the pure metal. Attempts made to drill this by ordinary methods failed; a diamond drill was then used when, after constant work for three days and nights at the rate of 5,000 R. P. M., only one-fourth of the thickness of the sheet had been drilled through, while the drill was so badly worn that the experiment was discontinued. Tantalum is entirely non-magnetic, its fusing point lies about 2,300 degrees Centigrade, and its specific gravity is 14 to 17. In the form of wire it sustains a load of about 128,000 pounds per square inch.

* * *

The *Foundry*, in speaking of strong brass and bronze, says that the Tobin brass alloys are supposed to give over 60,000 pounds in tensile strength. Government specifications for manganese bronze are understood to call for a tensile strength of 72,000 pounds per square inch. Such an alloy is as follows:

	Pounds.
Ingot copper	80
Manganese copper	8
Tin	6
Zinc	6

This will be difficult to cast sound and so will this, which is supposed to be stronger yet:

	Pounds.
Lake copper	96
Silicon copper	4
Aluminum	2

There is no doubt that considerable experimenting will be necessary before a satisfactory alloy for this pressure is found.

THE SPECIFIC HEAT OF SUPERHEATED STEAM

Until quite recently the value almost universally adopted for the specific heat of superheated steam at constant pressure has been 0.48, derived in 1840 from the results of three series of experiments by Regnault, which he considered the most reliable of his investigations upon this subject. The data from this series were:

Specific heat.	Pressure, Lb. per sq. in abs	Superheat Deg. C
0.48111	49	88
0.48080	33	86
0.47963	31	93

In steam calorimeter work where the temperatures come within the limits of Regnault's experiments, the value of 0.48 is probably correct; but with the high pressures and temperatures now being dealt with in power plants using superheated steam a much higher value should be taken.

In the case of tests upon superheaters and engines or turbines using superheated steam, the weight of the steam does not afford a fair basis for estimating the gain or loss from superheating, because weight alone gives no indication of the amount of heat in superheated steam of a given pressure, as is the case with saturated steam. With our present knowledge, the best way to compare results with and without superheat is by weighing the coal burned under the boiler. But if the specific heat of superheated steam were accurately known, it would be more satisfactory to calculate the efficiency of the apparatus on the basis of the heat units given up to or rejected by the steam at the different steps in the process.

The Importance of a Correct Value for Specific Heat.

The results of some tests will now be given to show to what extent calculated efficiency will vary when using different values for specific heat; also, to compare results when efficiency is calculated in heat units and in pounds of steam per horsepower hour.

The following results are from a test upon a Schmidt superheater reported by Prof. Jacobus in a paper in the proceedings of the A. S. M. E. for 1904.

Superheater Test.

Total dry coal consumed, in pounds	1,426
Heat of combustion of coal in B. T. U., per pound	14,060
Pressure of steam entering superheater, lb. per sq. in. gage	147.4
Temperature of steam entering superheater, deg. F.	365.6
Temperature of steam leaving superheater, deg. F.	809.1
Amount of superheating, deg. F.	443.5
Total weight of steam superheated	58,025
Weight of steam superheated per lb. of coal burned	40.69

In the foregoing test the heat of combustion of the coal was carefully determined by calorific tests, and the heat represented by the combustion of each pound of coal is thus known. The weight of steam flowing through the superheater per pound of coal burned, and the amount that it is superheated, are also known. If the specific heat of the steam could be correctly assumed therefore, it would be possible to calculate the amount of heat imparted to the steam per pound of coal burned, from which the efficiency of the superheater could be calculated.

In the table below, the efficiency is calculated on this basis, under the assumption that the specific heats are 0.48 in the first column; 0.6 in the second column, and 0.8 in the third column. For the first value the efficiency is 61.6 per cent, for the second, it is 77 per cent, and for the third it is practically 100 per cent, showing that the specific heat cannot be as high as 0.8. These figures illustrate of how much importance is a correct value of specific heat in calculations upon the efficiency of superheaters.

	Sp. heat = 0.48	Sp. heat = 0.6	Sp. heat = 0.8
Heat imparted to the steam in B. T. U.	12,352,000	15,440,000	20,587,000
Heat imparted to the steam per pound of coal burned in B. T. U.	8,662	10,827	14,436
Efficiency of superheater in per cent, based on heat of combustion of the coal	61.6	77.0	102.[illegible]

The reader who wishes to investigate these various experiments should procure a copy of the Journal of the Worcester Polytechnic Institute for November, 1904. It contains an article by Prof. Sidney A. Reeve, reviewing the work of different experimenters and gives references to the original documents where their results are reported.

Turbine Tests

To show the application of values of specific heat to tests of motors using superheated steam, the following data are given, from tests upon a De Laval steam turbine by Dean and Main. The turbine was tested both with saturated and superheated steam, under similar conditions, so that a direct comparison can be made between its performance when running with saturated and with superheated steam, and the gain from the use of superheated steam determined.

Test with Saturated Steam.

Dry steam entering turbine, pounds per hour	5,052
Initial pressure, lb. sq. in., gage	206.4
Total heat in steam, B. T. U. per pound	1,149.3
Brake horse-power	333
Steam used per brake horse-power per hour, pounds	15.17
B. T. U. per brake horse-power per hour	17,435

Test with Superheated Steam.

Weight steam entering turbine, pounds per hour	4,906
Initial pressure, lb. sq. in., gage	207
Superheat, degrees F.	84
Total heat in steam, B. T. U. per pound	
When sp. heat is taken = 0.48	1,190
When sp. heat is taken = 0.6	1,200
When sp. heat is taken = 0.8	1,217
Brake horse-power	352
Steam used per brake horse-power per hour, pounds	13.94
B. T. U. per brake horse-power per hour	
When sp. heat is taken = 0.48	16,590
When sp. heat is taken = 0.6	16,728
When sp. heat is taken = 0.8	16,965

Under the assumption of specific heats equal to 0.48, 0.6 and 0.8, the total heat contained in the steam and the number of heat units utilized per brake horse-power per hour were calculated as tabulated above. From these the gain from superheating was calculated under the three assumptions, giving the results shown below:

Gain from Superheating.

First, by taking the water consumption in pounds—

$$\frac{15.17 - 13.94}{15.17} = 0.081 = 8.1 \text{ per cent.}$$

Second, by taking the heat units in the steam consumed—

When sp. heat = 0.48

$$\frac{17.435 - 16.590}{17.435} = 0.0481 = 4.8 \text{ per cent}$$

When sp. heat = 0.6

$$\frac{17.435 - 16.728}{17.435} = 0.04 = 4 \text{ per cent}$$

When sp. heat = 0.8

$$\frac{17.435 - 16.967}{17.435} = 0.027 = 2.7 \text{ per cent}$$

The gain from superheating therefore calculated on the basis of heat units utilized (which is, of course, the correct basis) is much less than when on the basis of pounds of water per horse-power per hour. In the heat unit calculations the efficiency is seen to vary from 4.8 per cent to 2.7 per cent for the different values of specific heat, showing that the higher the value assumed the less the gain is found to be by using superheated steam.

Results of Tests to Determine Specific Heat

Many experimenters have attempted to derive values of the specific heat of superheated steam for other temperatures and pressures than covered by the tests of Regnault.

Among the more important work in this connection is that of Grindley in England, of Griessmann and Lorenz in Germany, and of Prof. Carpenter in this country. There are also now in progress at the National Physical Laboratory, Teddington, England, elaborate tests under the direction of the Manchester Steam Users' Association.

The results and conclusions of these various men are in the highest degree contradictory, and it can almost be said that one may arrive at any desired conclusion, or no conclusion at

all, from their work, according to one's method of sifting and sorting the results.

It has been held by authorities in thermodynamics that the specific heat of superheated steam at constant pressure is a function of the temperature but not of the pressure. On the basis of certain assumptions, which, however, are probably not correct, it can be demonstrated mathematically that such should be the case. From actual tests, however, the specific heat is found to be a function both of the temperature and of the pressure. A review of Grindley's results has been made by Prof. Reeve, of Worcester Polytechnic Institute, who, by recalculation of the values, concludes that they depend both upon temperature and pressure. He publishes tables giving the values of specific heat and also of the total heat of superheated steam for a limited range of temperatures and pressures, in his article in the *Journal of the Worcester Polytechnic Institute* previously referred to in the footnote.

One of the most useful reviews of the work of the different experimenters was contributed by Mr. George A. Orrok, chief draftsman of the New York Edison Co., to *Power* for August, 1904. He plotted the various values and found those of Griessmann to be the most consistent, and also to agree quite closely with those of Grindley, as recalculated by Reeve. Taking the Griessmann values as a basis Mr. Orrok deduces the following formula to represent them:

$$C_p = 0.00222 \ t_s - 0.116$$

in which t_s = temperature of the superheated steam.

The above formula gives the instantaneous or true specific heat at any temperature. The *mean* value of the specific heat between the points of saturation and any degree of superheat can be found by the formula

$$C_p = 0.00222 \left(\frac{t_s + t}{2}\right) - 0.116$$
$$= 0.00111 \ (t_s + t) - 0.116$$

To determine the total heat of superheated steam we have

Total heat $= \lambda + C_p \ (t_s - t)$ where

λ = total heat of saturated steam at the given pressure.

t_s = temperature of the superheated steam.

t = temperature of the saturated steam at the given pressure.

C_p = specific heat of the steam at constant pressure.

The value of λ is given in steam tables.

To illustrate the application of Orrok's formulas we will take the following data:

Steam pressure.................. 100 pounds absolute
Temperature of superheated steam....... 450 deg. F.

From the steam tables we obtain

$$t = 327.58$$
$$\lambda = 1{,}181.9$$

To calculate the instantaneous or *true* specific heat

$$C_p = 0.00222 \ t_s - 0.116$$
$$= 0.00222 \times 450 - 0.116$$
$$= 0.999 - 0.116$$
$$= 0.87$$

To find the *mean* specific heat between saturation and the temperature 450 degrees of the superheat, we have

$$C_p = 0.00111 \ (t_s + t) - 0.116$$
$$= 0.00111 \times 777.58 - 0.116$$
$$= 0.897 - 0.116$$
$$= 0.75$$

To find the total heat of superheated steam at 450 degrees temperature and 100 pounds pressure, we have

$$\text{Total heat} = \lambda + C_p \ (t_s - t)$$

in which C_p is the mean specific heat between the points of saturation and of the temperature of 450 degrees = 0.75, as found above. Hence

$$\text{Total heat} = 1{,}181.9 + 0.75 \ (450 - 327.58)$$
$$= 1{,}181.9 + 91.8$$
$$= 1{,}273.7$$

To show the closeness of Grindley's results, as recalculated by Reeve, and of Griessmann's values, as given by Orrok, we have compared below several values for total heat, taken at random from Reeve's table, with corresponding values calculated by using Orrok's formula for specific heat. The agreement is seen to be close, and as Orrok's formula for specific heat is a simple one to use, it apparently is as satisfactory as any that we have.

COMPARISON OF TOTAL HEATS, CALCULATED IN ACCORDANCE WITH RESULTS FROM GRINDLEY'S AND GRIESSMAN'S TESTS, AS PRESENTED BY PROF. REEVE AND GEORGE A. ORROK.

Absolute Pressure.	Temperatures of Superheated Steam.	Total Heat of Superheated Steam according to Reeve.	according to Orrok.	Difference between the two Values.
30	275	1,169.3	1,169.8	0.5
30	320	1,194.88	1,194.3	0.58
51.5	300	1,176.86	1,177.4	0.54
51.5	330	1,195.4	1,194.9	0.5
78.5	330	1,187.61	1,188.2	0.59
124.5	355	1,194	1,194.2	0.2
149.5	364	1,195.07	1,195.2	0.13

In 1901 Prof. Lorenz undertook an extensive series of experiments upon the specific heat of steam, extending over a wide range of pressures and temperatures. His work was under the direction of the *Vereines Deutscher Ingenieure* and is reviewed by Robert H. Smith in the *Engineer* (London), July 8, 1904. The peculiarity of the results of Prof. Lorenz is that while they indicate an increase of specific heat with the pressure, they also show a decrease with increase of temperature. Further than to make the above general statement Prof. Lorenz does not attempt to deduce any law. He remarks that for low pressures Regnault's value of 0.48 seems to hold good, while for high pressures 0.6 is approximately correct. An inspection of the table published in the *Engineer* shows that a large increase in temperature, accompanied by a slight increase in pressure, can take place without any change in the specific heat, owing to the opposite effects of the temperature and pressure upon the specific heat, as determined by Prof. Lorenz.

It now remains to refer to the tests conducted under the direction of Prof. R. C. Carpenter, at Cornell University. Experiments began in 1891 and were carried on at different times over a period of several years. The later tests were made by Prof. C. R. Jones of West Virginia University, who was taking a post-graduate course at Cornell. As a result of the latter's work Prof. Carpenter has published the following values:

Absolute Pressure.	Specific Heat.	Absolute Pressure.	Specific Heat.
14.7	.484	80	0.563
20	.492	100	0.614
40	.523	120	0.645
60	.553		

These results may be expressed by the equation

$$C_p = 0.462 + 0.001525 \ p.$$

where p is the absolute pressure.

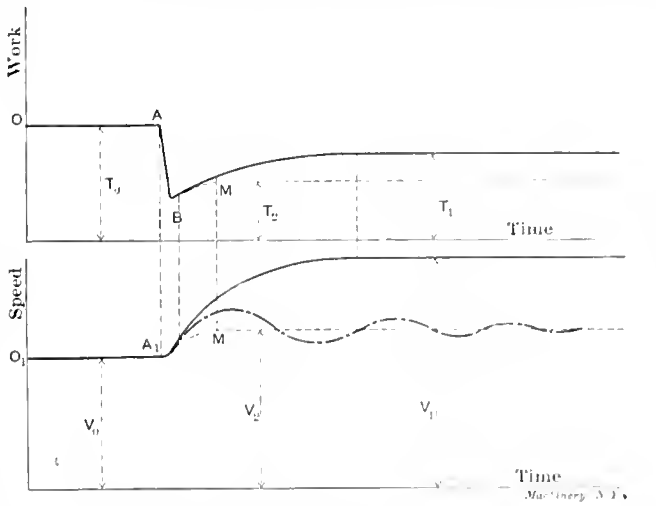
The apparent specific heat, therefore, at constant pressure, as deduced by Profs. Carpenter and Jones, is 0.484 at atmospheric pressure, and increases with the increase of pressure, becoming about 0.645 at 120 pounds absolute. Prof. Carpenter states that if there is any increase of specific heat with increase of temperature for a constant pressure, it is so slight as to be obscured by errors of instruments or of observation in the experiments, in which the degree of superheat ranges from 90 degrees to 30 degrees in excess of the temperature of saturated steam.

In view of the contention of some writers in thermodynamics that specific heat at constant pressure of superheated steam is a function of the temperature only, the Sibley College results are of unusual interest, and the writer has corresponded with Prof. Jones in regard to the matter, who replies that with the apparatus in operation he thinks it would not require very much time to convince any engineer that the specific heat does increase with the pressure. He states that his experiments with varying temperatures were made with steam at 20 pounds gage pressure and at temperatures running from the normal temperature of saturated steam to about 400 deg. F. The higher and lower temperatures in each experiment were kept about 10 degrees apart, that is, steam would be taken in at 300 degrees, say, and discharged at 290 degrees. When the tests were finished it was supposed that there were sufficient data to draw some definite conclusions in regard to the variation of the specific heat with the temperature; but when the final results were obtained the variations were found to be so slight that no conclusion in regard to the subject could be deduced, after making corrections for radiation.

THE BOUVIER GOVERNOR FOR WATER TURBINES.

DR. ALFRED GRADENWITZ.

For the consideration of the effect of a regulator for water turbines the diagrams given in figures 1 and 2 are drawn, representing work and speed respectively to a base line of time. If now a turbine rotating at a uniform speed V_0 and driving any kind of machine which absorbs an amount of energy T_0 at the given speed, be considered, a straight line O A, Figure 1, representing the resisting energy T_0, and the line O_1 A_1 (Figure 2), representing the uniform speed V_0, will be obtained. If now at a given moment corresponding to the points A and A_1, Figs 1 and 2, the resisting energy T_0 be altered suddenly



Figs. 1 and 2. Diagrams showing Variations of Work and Speed of a Water Wheel under different conditions for a given time.

without the aperture of the turbine being varied, a change of speed will be produced, and after a certain time the speed will have become V_1, such variation of speed obviously being greater as the variation in load has been greater. This variation of speed takes place with an acceleration which gradually diminishes, becoming zero when the whole set possesses its new normal speed. Letting A B in Figure 1 represent a sudden diminution of the resisting work, the curve of speeds and the curve of resisting work will assume the shapes shown in full lines in figures 1 and 2; the new values T_1 and V_1 being the reslsting work and speed corresponding to the new conditions. If, however, a regulator acting on the gate mechanism of the turbine be used, the equilibrium between the motive and re-

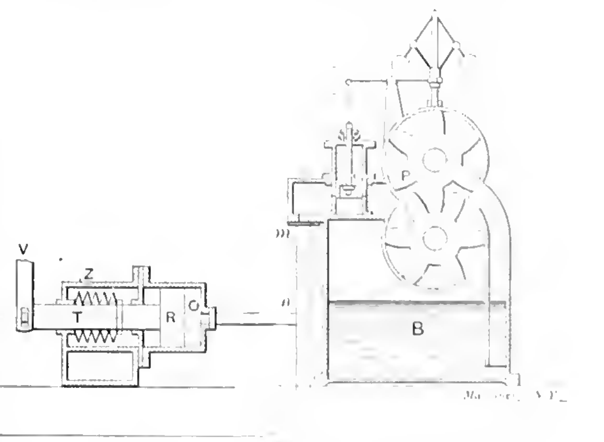


Fig. 4. Diagram of the Bouvier Governor. The Pipe at the bottom may be in communication with other Regulating Cylinders

sisting forces will be reached much more rapidly, supposing the same variation to take place in the resisting work, and the speed curve will assume the shape shown in dotted lines in Fig. 2 up to the point M, where equilibrium between these forces is obtained. If at this moment the action of the regulator could be discontinued, another normal speed V_2 would be obtained, this speed being less different from V_0 than was V_1. For a given variation of the resisting work it is always possible thus to so calculate the moving masses and the speed of working of the regulator that the difference V_2-V_0 shall not be beyond a given limit. The ideal condition for the working of a regulator would thus consist in a very rapid a[illegible] locking gates of the turbine, this action ceasing comp[illegible] as the motive forces compensate the resisting forces.

In practice up to this time there has always been a certain "hunting" of the governor. The governor has not been designed to act immediately on the water supply, but has been confined to stopping or starting an auxiliary motor, the energy of which is derived either from the turbine itself or from the water submitted to pressure. The connection between the governor and the auxiliary motor was formerly a simple engaging or disengaging device. With this arrangement the movement of the slide gate will not cease exactly at the moment of equilibrium between the forces, the oscillations thus resulting from the repeated action of the governor being similar to those represented in the dot and dash curve in Fig. 2.

These oscillations are avoided in an apparatus recently patented by A. and H. Bouvier, Grenoble, France, in which any disturbance occurring in the resisting work is immediately corrected by a corresponding displacement of the gate mechanism, so that another state of equilibrium follows immediately upon the intial state. This apparatus is illustrated in Fig. 4. The liquid is pumped through an orifice by a pump P of a practically constant output, the amount of opening of this orifice being altered by the displacement of a piston, whose position is controlled by a fly ball governor. For every position of the piston there will eventually be a given pressure in the discharge pipe of the pump, this pressure being inversely proportional to the area of the valve opening at any moment for a constant output. If the speed of the governor is increased the aperture of the opening will diminish progressively, as the

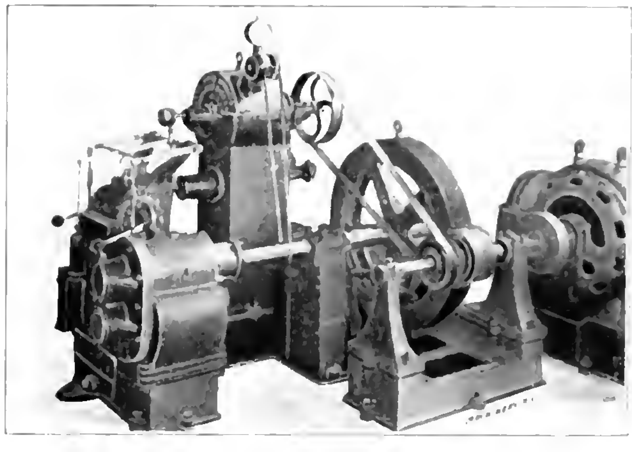


Fig 3 Details of the Central Regulating Apparatus in the Bournillon Power House

pressure augments. On the speed becoming constant the governor socket ceases to rise, so that the discharge pressure of the pump ceasing to increase, retains a given value that corresponds to the position of the slide. The pressure produced in the discharge pipe acts on a piston R in Fig. 4 this piston being counteracted by a spring Z; the piston R occupies a perfectly determined position for each value of the pressure of the water pumped. The piston R being rigidly connected to the regulating slides of the turbine there can be for a given position of the governor at any moment but a single possible position of the locking gate.

In operation, if the motor rotating at a uniform angular speed V_0 is suddenly relieved of part of its load the angular speed will augument, the governor rise and the valve diminish the aperture of the discharge opening, while the pressure augmenting, the spring will be compressed and the sluice gates be closed more and more. This action of the gate mechanism, however, ceases at the very moment when the motive forces have become equal to the resisting forces, when the pressure becoming constant the compression of the spring ceases and the whole system is in another state of equilibrium at an angular speed V_2, a little superior to the initial speed V_0. If, however, the resisting work had increased suddenly the speed would have diminished and the pressure of the liquid become less, so that the spring being expanded any displacement would have been stopped as soon as the diminution of speed had ceased. The variation of speed V_2-V_0 can be made as small as desired for a given variation of load with this governor, if

the moving masses are properly calculated. A simple contrivance allows the speed to be restored from the speed V_2 to the initial speed V_0 if it should be desired to keep the speed at accurately constant figures.

Where too great an amount of energy would be consumed in the displacement of the gate mechanism if the piston R acted directly on this mechanism as described, the apparatus is completed by an additional hydraulic motor constituting a relay, so that the piston R has only to control the distribution valve of this motor, the piston of the motor following exactly

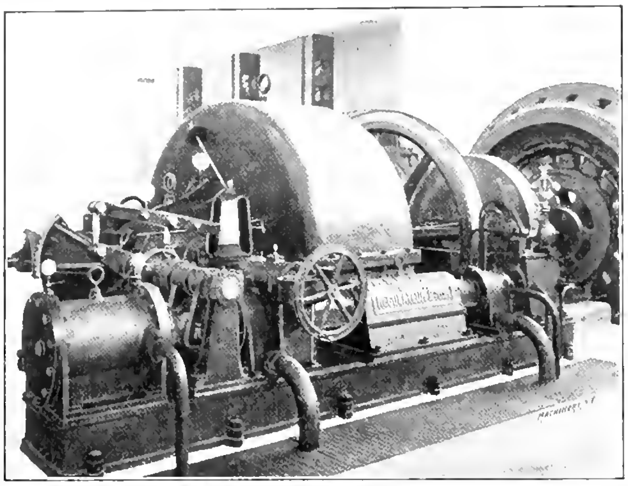


Fig. 5. A single Electro-hydraulic Generating Set with its Regulator at the Bournillon Power House.

and instantaneously any displacement of the valve. The motor can be worked with the motive water if there is a sufficient head available, there being no sensitive parts. If the fall is not sufficient the motor is actuated by a liquid under pressure, derived from an accumulator fed by pumps. With this additional motor it is of course the piston of the motor which controls the locking gates of the turbine.

The apparatus is adapted for the simultaneous regulation of a set of hydraulic motors driving alternators connected in parallel, each motor being fitted with a pressure cylinder and springs Z, like that shown in Fig. 4. The pressure produced

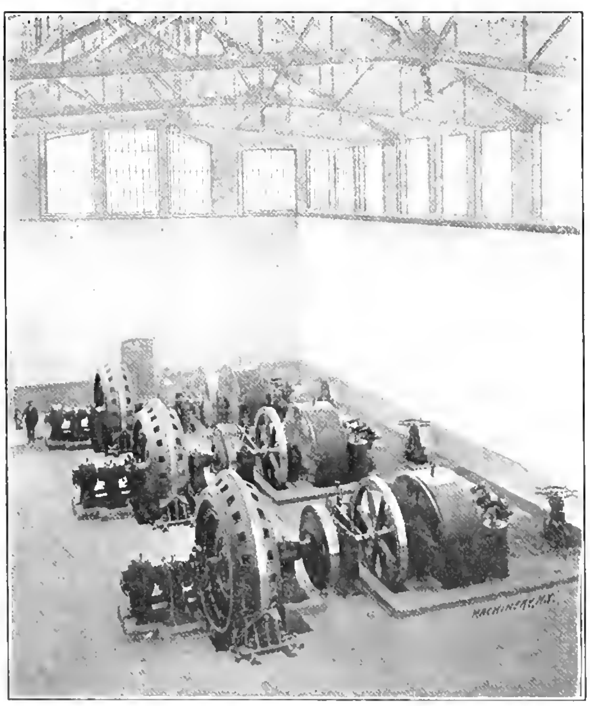


Fig. 6. Three Generator Sets with one Central Regulator, Bournillon Power House.

by the pump P in Fig. 4 may be transmitted simultaneously to the locking devices of each of the motors, and if these motors be exactly similar and the springs Z of the various regulating devices be adjusted similarly, the locking gates of the turbines will all be in the same position for the same pressure of water in the various pressure cylinders and the alternators will hence be put to equal loads. If the turbines have different outputs the various springs Z will have to be so adjusted that the motors always work at the same fractions of their output. In central stations a single centrifugal force governor will be sufficient to regulate the speed of all the motors, as shown in Fig. 6, which represents three generator sets with one central regulator as applied by Messrs. Bouvier in a recent hydro-electric installation at Bourillon (Isère). This plant being intended for supplying the town of Vienne (Isère) with power and light, includes three turbines with 1,250 H. P., making 375 revolutions per minute, under a head of 98 meters. The machine shops are, however, to be fitted with three additional sets of 1,250 H. P. working under a pressure of 300 meters.

The central regulator installed according to the above system controls the locking devices of the three turbines at present installed, as shown in Fig. 6. The details of the central apparatus are shown in Fig. 3, and a view of a single set with its regulator in the Bournillon power house is disclosed in Fig. 5. The official tests made on the delivery of the turbine proved the small variation of speed allowed by the regulator. From one of these tests we see that by cutting out instantaneously

a load of 500 H. P. a variation of speed of 6 revolutions;
a load of 670 H. P. a variation of speed of 9 revolutions;
a load of 900 H. P. a variation of speed of 12 revolutions;
a load of 1,000 H. P. a variation of speed of 13 revolutions,

has been recorded, the normal angular speed of the turbine being 375 revolutions per minute and its maximum output 1,250 H. P.

* * *

BALANCING MOVING PARTS.

One bad feature of the slotter as ordinarily constructed is the counterweight. The vertical travel of the ram makes it necessary to balance this weight. In most machines this is effected by a pivoted arm connected with the ram at one end and carrying a counterweight at the other. In order to save weight in the counterweight, it is the almost universal practice to make the counterweight arm longer than the distance from the pivot to the ram. Now while it is possible to effect a standing balance with this construction, it is not possible to secure a dynamic balance. In other words a standing is not the same as a running balance. The faster the slotter works, the greater is the difference in unbalanced forces, since the kinetic energy of the mass of the ram and counterweight both increase with the square of the velocity. With its long arm the counterweight must necessarily increase in kinetic energy faster than the ram, hence when working at high speeds there is a noticeable lack of balance in slotter action. Properly constructed the counterweight arm should be of the same length as the arm connecting the ram, and then no matter at what speed the ram is operated, the balance will be unchanged. A type of slotter meeting this requirement is that having the ram balanced by a wire rope or chain running over pulleys and connected to a counterweight on the opposite side. And, in general, the balancing of a machine should be accomplished, if possible, by the use of counterweights of the same weight as the parts to be balanced, and moving at the same velocity.

* * *

Frank W. Mahin, Consul at Nottingham, England, writes that the Elektricitäts-Aktien-Gesellschaft, of Frankfort, has recently introduced a machine for testing the lubricating qualities of oils. The essential part is a short shaft working in a bearing, and loaded appropriately. About half a pint of the oil under examination is poured on the bearing, and the shaft is set revolving at a definite speed. The time that elapses before the shaft comes to rest is noted; the greater the time the better is the lubricating quality of the oil. After the test the bearing is cleaned by pouring over it a liquid in which the oil is soluble, and then removing the liquid by a blast of air. This method of cleaning is found to be quite effective and is economical of time. The machine may be driven by an electric motor or other mechanical means or by hand, and there is an arrangement of resistance coils by which the bearing can be heated up to any required temperature. Both the bearing pressure and the speed may be conveniently regulated.

AN EXAMPLE OF WORM GEARING.

OSCAR E. PERRIGO, M. E.

It is a well-known fact that the power required for boring large holes in hard metals is a severe test to any arrangement of gearing designed for the purpose, particularly when rapid work is expected to be accomplished, and that it is a matter of congratulation to the builder when such mechanism successfully withstands the strains incident to the hard usage to which it is necessarily subjected. This is still further enhanced when the mechanism successfully meets these rigid requirements year after year with no apparent deterioration, or expense for the repairs usually expected in this class of machines.

A case in point which well illustrates these features is the heavy boring lathe, a rear elevation of which is shown in Fig. 1. This lathe has a headstock heavily back-geared and provided with a three-step driving cone, for an extra wide belt, thus giving it an abundance of driving power for all work expected of it. The bed is extra heavy and deep, so as to resist the heavy strains put upon it by the strongly geared feeding mechanism, and was built considerably longer than is shown in the engraving, and provided with a center support.

The boring tools are carried by a 15-inch turret, *A*, pivoted upon a heavy top slide, *B*, four feet long, so as to give a travel of three feet. This slide is in turn supported upon a substantial base, *C*, secured to the bed at any desired point by clamps operated by four eccentrics (not shown). The turret is clamped in place by the hand lever, *a*, as usual, and has, for additional security, a projecting flange, *b*, provided with grooves opposite each of the tool holes, in which engages a securely pivoted lever (not shown).

The feed arrangement is constructed as simply and with as few pieces as possible. Upon the under side of the slide, *B*, is secured a wide steel rack, *D*, of coarse pitch, and engaging a cast steel pinion on the shaft upon the outer end of which is fixed the main worm wheel, *F*, which is engaged by the main worm, *G*. This worm is fixed upon a vertical shaft, *H*, journaled in the bracket box, *J*, bolted to the base, *C*. Upon the lower end of the vertical shaft, *H*, is fixed the secondary worm gear, *K*, engaging the secondary worm carried by the feed shaft, *L*, which is driven by a series of change gears at the headstock in the usual manner. The worm gears, *F* and *K*, are of the best quality of close-grained cast iron and the worms and their shafts of 40-point carbon steel. To provide for the severe upward thrust of the worm shaft, *H*, an anti-friction washer is placed over it and held down by a hardened steel screw, *h*, secured by a check nut as shown. Beneath the worm on the feed shaft, *L*, and also under the main worm wheel, *F*, are pockets for holding a quantity of heavy oil suitable for the use of worm gearing. With the exception of being of unusual strength the parts are of ordinary construction and arrangement except the worm gears.

Many good mechanics are prone to object to any kind of a worm gear, and can cite numerous examples wherein they have proven failures and utterly worthless for the purposes intended, until there is a very strong prejudice against them in any form. The writer is of the opinion that [illegible] only one practical objection to a properly constructed [illegible] gear, and that is, it must be constantly lubricated, and [illegible] running machines in which they are used are very liable to forget this fact altogether.

The principal, and almost the only reason why worm gears fail to give satisfactory results is that usually they are not properly designed at first. Another is that they are not properly hobbed out, and sometimes not hobbed at all. It is the purpose of this article to point out how they should be designed in order that they may be successful, and to present the machine shown in Fig. 1, as an example of their practical utility when properly constructed.

There are various methods for determining the diameter of the pitch circle of a worm gear. One authority takes the outside diameter of the turned blank, at its smallest diameter, or throat, as proper. Another takes the diameter of the bottoms of the teeth at the extreme edge of the cut gear. Still another, the point where the pitch line of the worm intersects the center line passing through the worm and worm gears. All of these are more or less in error, as they do not take proper account of the width of the face of the gear. If the teeth are straight, as in a spur gear, we naturally take a point in the center of the teeth (after subtracting the clearance) as the pitch line. Now when we have a curved tooth it is obviously not proper to do this, as the actual working pitch diameter must be somewhat larger than this. But how much larger should evidently be determined by the amount of contact with the worm, that is, the angle within which this contact is to be, the width of face being in turn controlled by the diameter of the worm.

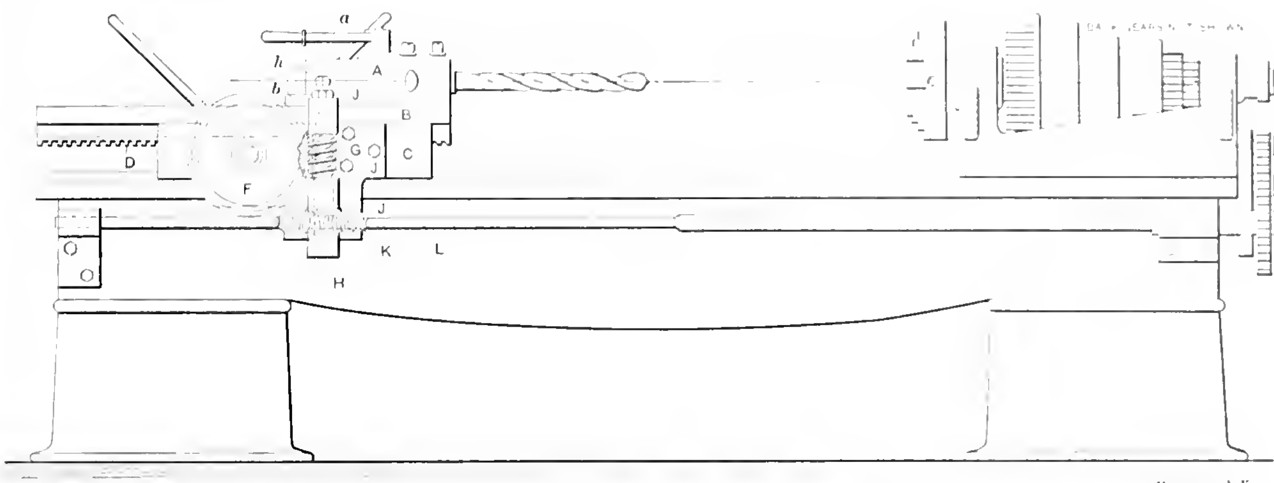


Fig. 1. Heavy Boring Lathe, Rear Elevation, showing Worm Gear Feed Arrangement

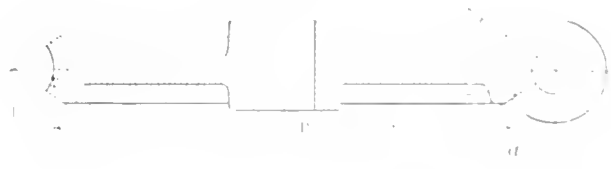


Fig. 2. Method of Determining Pitch Diameter of Worm Gear

Practically the face of the worm gear is about equal to one-half the outside diameter of the worm, but the matter is best considered by saying that the inclosing angle of contact should not be less than 45 degrees nor more than 80 degrees, while from 60 degrees to 70 degrees will be found most useful. The writer has found by ample practice that the true working pitch diameter is most nearly determined by the method shown in Fig. 2, which represents a worm wheel having a contact of 70 degrees. To determine the pitch diameter divide the arc of the pitch line of the worm contained between the center line and one of the lines of the enclosing angle, *a*, to three equal parts, and draw the line, *x*, at the intersection of the second line from the center line. This will give the point from which to measure the pitch diameter. If this is laid out on a large scale and with various angles of contact, the difference between it and the usual methods will be more clearly shown than it is in the engraving, and it will be found to make from

two to four teeth difference from those methods in a worm wheel of, say 12 inches diameter.

All worm gears should, of course, be hobbed out, and the thread of the worm made to carefully conform to that of the hob. The sides of the thread are usually of a 15-degree angle.

Now as to the proof of the correctness of this method, which the writer has used successfully for years. The machine shown will readily bore 3-inch holes in 50-point carbon steel spindles. In several cases where a 5⅛-inch hole was required, it was first bored 2 inches and then a boring bar, provided with two double-end cutters, was introduced, enlarging the hole from 2 inches to 5⅛ inches at one cut and taking out nearly thirty pounds of chips per hour.

One end of the spindle to be bored is held in the chuck and the other end supported by an ordinary center rest. Oil or drilling compound is forced through a tube to the point of the drill, or the cutters, lubricating the cutting edges and washing out the chips.

This machine has been in use for over seven years, and the same worms and worm gears are on it that were put on when the machine was first built, and they are in good condition for as many years more of good service. The working faces do not seem to have changed their original form during the entire time, which is taken as ample evidence that they were right originally, as the writer has frequently seen worm gears in lathe aprons, designed after the usual methods, entirely worn out with six or eight months' service.

* * *

NOTES ON THE STRENGTH OF BEAMS, PLATES AND COLUMNS.

R. P. KING.

Some time ago I noticed in your columns an explanation of a simple method of finding the strength of beams, using moments. I had in mind at that time writing a letter on this subject, but have not until lately had time to do so.

It has always seemed to me that beam calculations were simpler by the method of the moment of resistance than by finding the bending moment. Fig. 1 is the table to be used in connection with this method. It differs from the method by moments in that the sign M, the bending moment, does not figure at all, its place being taken by the moment of resistance, and the weight or load, W, comes out of the formula directly. The values of f are the ones usually found and are on the sheet merely to make the whole complete for office use. A table explaining the notation will be found further along.

As to the derivation of this table, take for example Case 7. As usually given, $M = \frac{W\,l}{2}$, in which l is expressed in inches. Substitute for the bending moment, M, the moment of resistance $S\,Z$ and let L = length in feet. Then

$$S\,Z = \frac{12\,W\,L}{2} \text{ or } W = \frac{2\,S\,Z}{12\,L}$$

In looking through these formulas one notices a similarity, or even more than a similarity. In the table below, the points of difference are set forth. Let $a = \frac{S\,Z}{12\,L}$, then in

Case 1 $W = a$.
Case 2 $W = 4\,a$.
Case 4 $W = \frac{16}{3}\,a$.
Case 5 $W = 8\,a$.
Case 7 $W = 2\,a$.
Case 8 $W = 8\,a$.
Case 9 $W = 8\,a$.
Case 10 $W = 12\,a$.

In the handbooks on structural steel are tables for different sections used as beams, supported at both ends, and uniformly loaded, conforming to Case 8. By referring to the above table it will be readily seen that in order to substitute Case 1 for Case 8, we have only to divide the safe load given in the handbook for the section and span in question, by 8.

The factor of safety given in these tables may also be changed to conform to other conditions, the factor in the table being 4. For instance, suppose a case where we have a cantilever beam conforming to Case 7, but the load is a live load and we wish to use a safety factor of 8. We see that the safe load varies as 2 is to 8, and the safety factor varies as 4 is to 8, so all we have to do is to multiply the load calculated for case 7 by 8, i. e., $\frac{8}{2} \times \frac{8}{4}$, and in the book we find the most economical section for this load for the given span.

When designing machinery, it is quite often necessary to know how to determine the section modulus quickly. In order to do this we must first find the neutral axis and the moment of inertia. The neutral axis is that portion of the beam where no bending takes place and is usually assumed to be at the center of gravity of the section. While this is probably not rigorously true in any case, it may be assumed as sufficiently so for all practical purposes.

If a section has an axis of symmetry, the center of gravity is somewhere on this line. If it has two axes of symmetry the C. G. is at the intersection. If the section has one axis, draw a line perpendicular to that axis. Divide the section into small figures the C. G. of which may be easily found, rectangles being the ideal figures. Multiply each area by the distance from its C. G. to the perpendicular line and divide the sum of these products by the entire area of the section.

If the section has no axis, draw two lines at 90 degrees and determine the C. G. with reference to one of the lines as directed above, then with reference to the other, and the C. G. will be at the intersection of the two resultant lines.

Table showing Notation used in the Formulas.

L = Length in feet.
l = Length in inches.
I = Moment of inertia.
E = Modulus of elasticity.
W = Load in pounds.
S = Stress in pounds per square inch.
Z = Section modulus.
M = Bending moment.
f = Deflection in inches.
r = radius of gyration with reference to a neutral axis perpendicular to the plane of flexure.
d and D = Diameters in inches.
p = Pressure pounds per square inch.
t = Thickness in inches.
K = Constant.
C and C' = length in inches.

To determine the moment of inertia, divide the section into many small parts and multiply the area of each part by the square of the distance from its C. G. to the neutral axis; the sum of these products will be the moment of inertia. The results by this rule will always be a little small.

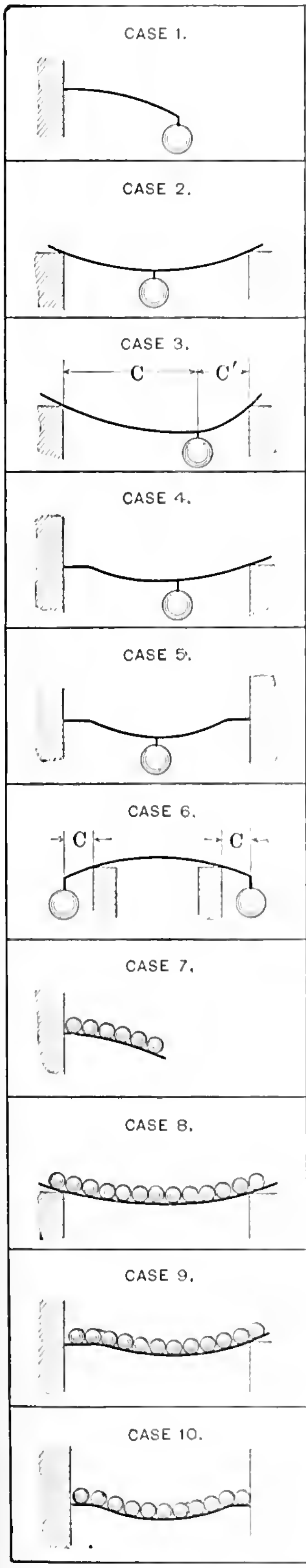
We are now ready for the section modulus. Divide the moment of inertia of the cross section of a beam by the distance from the neutral axis to the extreme fiber, i.e., the fiber that is farthest from the axis, and the quotient will be the modulus of the section.

The modulus of ordinary sections is given in all pocket books. The section modulus for rectangular sections is $\frac{b\,d^2}{6}$, where d = depth of beam and b = breadth. This quantity is used in calculating timber beams, among other things, and I want to call attention to the ease with which these beams may be varied. For instance, a beam 6 x 8 placed edgeways, was found to be too light for a certain load. As the beam varies in strength directly as its breadth and as the square of its depth it is easily seen that a beam 8 x 8 would support one-third more, or the loads could be in proportion as 6 is to 8. A beam 6 x 16 placed edgeways would hold four times the load held by the 6 x 8. The strength of round beams varies as the cube of the diameter and nearly all regular shapes will vary in some such way.

The strength of a beam also varies in inverse proportion to its length, so that a beam that is safe under a given load will support twice that load if the length of the beam is one-half. There are two exceptions to the above, one when the load is so great that the beam is crushed, and one where the

beam fails from shearing off at the supports. Under ordinary circumstances, neither of these will occur.

The treatment of composite beams is more complex, yet may be reduced to a simple form that is easily calculated and is approximately correct. These beams are of steel and cast iron, steel and wood, or steel and concrete, and should be so designed that the steel alone is to take the tension, while the other material is depended upon to take the compression.



Case		Formulas
CASE 1.	CANTILEVER. LOAD CONCENTRATED.	$W = \frac{SZ}{12L}$ $f = \frac{(12L)^3 W}{3IE}$
CASE 2.	SUPPORTED BOTH ENDS. LOAD CONCENTRATED.	$W = \frac{4SZ}{12L}$ $f = \frac{(12L)^3 W}{48IE}$
CASE 3.	SUPPORTED BOTH ENDS. LOAD CONCENTRATED AT ANY POINT.	$W = \frac{12LSZ}{CC'}$ $f = \frac{(12L)^3 W}{3IE} \times \frac{C^2}{L^2} \times \frac{(C')^2}{L^2}$
CASE 4.	FIXED AT ONE END, SUPPORTED AT OTHER. LOAD CONCENTRATED.	$W = \frac{16SZ}{3(12L)}$ $f = \frac{W}{IE} \times \frac{(12L)^3 7}{768}$
CASE 5.	FIXED AT BOTH ENDS. LOAD CONCENTRATED.	$W = \frac{8SZ}{12L}$ $f = \frac{W}{IE} \times \frac{(12L)^3}{192}$
CASE 6.	LOADS OVERHUNG. BOTH LOADS CONCENTRATED	$W = \frac{SZ}{C}$ at each End $f = \frac{W}{IE} \times \frac{(12L)^3}{8} \times \frac{C}{(12L)}$
CASE 7.	CANTILEVER. LOAD UNIFORM.	$W = \frac{2SZ}{12L}$ $f = \frac{W}{IE} \times \frac{(12L)^3}{8}$
CASE 8.	SUPPORTED BOTH ENDS. LOAD UNIFORM.	$W = \frac{8SZ}{12L}$ $f = \frac{W}{IE} \times \frac{5(12L)^3}{384}$
CASE 9.	FIXED AT ONE END, SUPPORTED AT OTHER. LOAD UNIFORM.	$W = \frac{8SZ}{12L}$ $f = \frac{W}{IE} \times \frac{(12L)^3}{192}$
CASE 10.	FIXED AT BOTH ENDS. LOAD UNIFORM.	$W = \frac{12SZ}{12L}$ $f = \frac{W}{IE} \times \frac{(12L)^3}{384}$

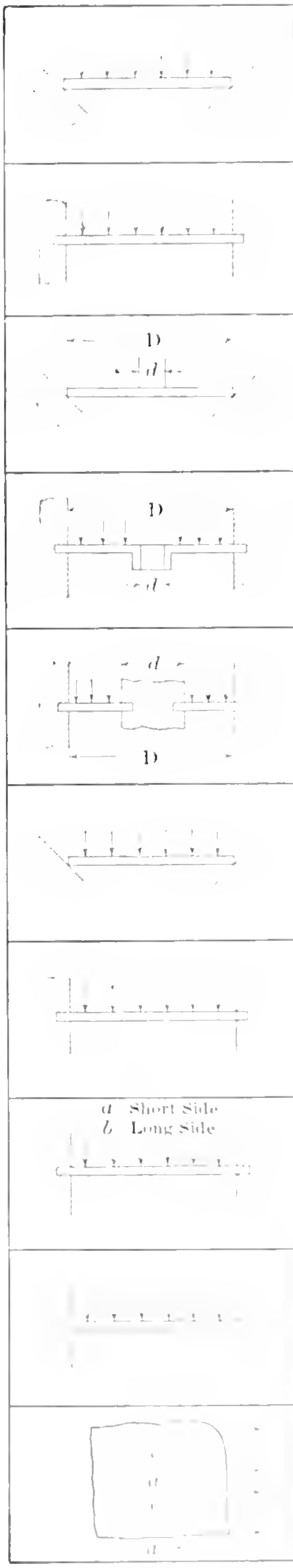
Machinery, N.Y.

Fig. 1. Table of Beam Calculations

In every beam the total compression equals the total tension, otherwise the beam would fail. Let us start with this condition and endeavor to find a simple way to calculate a reinforced concrete steel beam for a given load at a given span. The form of such a beam will be a rectangle and we may further simplify by assuming that the breadth of the beam is one inch. To figure the depth of the beam, [illegible] that we forget for the time being that any steel is to be used and calculate the beam by the formula of Case 8, Fig. 1.

$$W = \frac{8SZ}{12L} \text{ where } Z = \frac{bd^2}{6}.$$

If the compressive strength of the concrete is 600 pounds per



ROUND PLATE
$t = d \sqrt{\frac{5p}{24s}}$
ROUND PLATE
$t = d \sqrt{\frac{p}{6s}}$
ROUND PLATE $t = K \sqrt{\frac{p}{s}}$
When $\frac{D}{d}$ = 10, 20, 30, 40, 50; K = 1.138, 1.296, 1.327, 1.351, 1.367
ROUND PLATE $\frac{d}{D}$ = 0.1, 0.2, 0.3; K = 0.152, 0.286, 0.324
$t = K d \sqrt{\frac{p}{s}}$
ROUND PLATE $\frac{d}{D}$ = 0.3, 0.4, 0.5; K = 0.276, 0.225, 0.182
$t = K d \sqrt{\frac{p}{s}}$
SQUARE PLATE a = Side of Square
$t = 0.156\ a \sqrt{\frac{p}{s}}$
SQUARE PLATE a = Side of Square
$t = \frac{a}{2} \sqrt{\frac{p}{s}}$
RECTANGULAR PLATE a and b = Sides of Rectangle
$t = 0.5\ a b \sqrt{\frac{p}{(a^2 + b^2) s}}$
ELLIPTIC PLATE a = Major Axis, b = Minor Axis
[illegible]
STAYED PLATE a = [illegible] Stay [illegible]
$t = 0.47\ a \sqrt{\frac{p}{s}}$

Machinery, N.Y.

Fig. 2. Formulas for the Strength of Flat Plates

square inch and we assume the tensile strength to be the same (which it is not), we can calculate the depth of the beam to be D inches, Fig. 3.

We will now proceed to put in the steel. In most cases it will be found about right to make n = [illegible]. In any case the

tension = area of the steel bars per unit $b \times m \times$ the strength of the steel. This may be put into a formula, but is quite as easily handled as given above.

For the strength of columns, we use Gordon's formulas, adapted from Hodgkinson's, and which are given in Fig. 4. In these formulas the values of p are per square inch of section

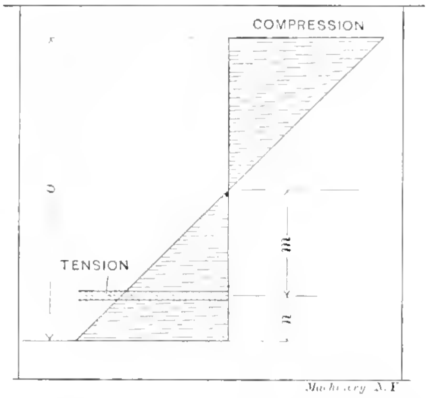


Fig. 3. Calculation for Reinforced Concrete Steel Beam.

and are the ultimate stresses. To find the safe load for a given section it is necessary to multiply p by the area of the section and divide by the factor of safety.

These formulas seem more epecially adapted to building and bridge design, but if we consider a piston rod as a column with square bearings, and a connecting rod a column with pin bearings, their adaptation to machine design becomes apparent. Perhaps the term compression bars would suit this subject better than columns. In these formulas we have r, the radius of gyration. To determine the square of the radius of gyration, it is only necessary to divide the moment of inertia by the area of the section. The value of r^2 is, however, given in the hand books for all ordinary sections.

STEEL COLUMN SQUARE BEARINGS	$p = \dfrac{50{,}000}{1 + \dfrac{(12\,L)^2}{36{,}000\, r^2}}$
STEEL COLUMN ONE SQUARE AND ONE PIN BEARING	$p = \dfrac{50{,}000}{1 + \dfrac{(12\,L)^2}{24{,}000\, r^2}}$
STEEL COLUMN PIN BEARINGS	$p = \dfrac{50{,}000}{1 + \dfrac{(12\,L)^2}{18{,}000\, r^2}}$
CAST-IRON COLUMN SQUARE BEARINGS d	$p = \dfrac{80{,}000}{1 + \dfrac{(12\,L)^2}{800\, d^2}}$
CAST-IRON COLUMN SQUARE BEARINGS d	$p = \dfrac{80{,}000}{1 + \dfrac{(12\,L)^2}{1{,}067\, d^2}}$
WOOD COLUMN SQUARE BEARINGS b	$p = \dfrac{5{,}000}{1 + \dfrac{(12\,L)^2}{250\, b^2}}$

Machinery, N.Y.

Fig. 4 Strength of Columns, from Gordon's Formulas, adapted from Hodgkinson's.

Fig. 2 is a chart for the strength of flat plates, and most of the formulas are due to Grashof. Very little explanation is necessary, as the formulas are all rather simple. When the constant K is used, its value is found from $\dfrac{d}{D}$ or vice versa. The notation used in the different charts is given in the table on page 526.

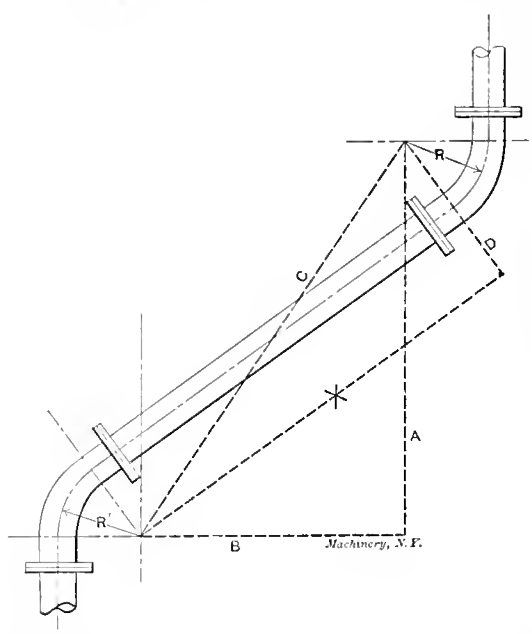
Having the formulas in tabulated form it only remains for the draftsman to select the correct one and apply it. The habit of correctly analyzing simple cases is easily acquired and is a long step toward the goal that every draftsman should strive to attain.

I might add in closing that the habit of checking all calculations by one's eye is a fine thing to cultivate, for sometimes an error will occur that is so ridiculously wrong that it is immediately "spotted" and the work revised to conform. Many times other questions than mere strength enter in, as for instance, rigidity as required by a machine tool; or strains due to expansion and contraction as shown in the cooling of cast iron, especially in the arms of pulleys and bevel gears. In such cases empirical formulas and experience are the best guides.

* * *

METHODS FOR OBTAINING THE DISTANCE BETWEEN ELLS TO CONNECT PARALLEL LINES OF PIPE.

Mr. E. C. Falk, Torrington, Conn., submits his method, illustrated below, for obtaining the distance between two ells to connect two parallel lines of pipe. Referring to the solution of this problem in the February number of MACHINERY by Mr. Franklin H. Smith, Mr. Falk states that he considers his solution simpler, and that it can be used without regard to the magnitude of the angles, and without the use of constants.



The Distance between Ells to Connect Parallel Lines of Pipe.

In the figure, A, B, R and R' are generally known or determined beforehand, B being the distance between the two ells of pipe minus the sum of the two radii, and A being the distance parallel to the lines of pipe between the points of offset of the two ells, which points can be determined from the maker's catalogue if standard ells are used. Then

$C = \sqrt{A^2 + B^2}$,

$D = R + R'$, and

$X = \sqrt{C^2 - D^2}$, which makes the formula

$X = \sqrt{A^2 + B^2 - (R + R')^2}$

If the distance between the flanges of the ells is desired, this will be the distance X minus the sum of the two offsets of the ells.

* * *

Under Shop Receipts and Formulas, April, 1905, the item "Steel Hardening and Tempering Compound" was attributed to H. S. Hindman, Columbus, Ohio. It should have been W. S. Hindman, Columbus, Ga.

REPAIRING FIELD COILS.

NORMAN O. MEADE.

Only a general description of field-coil winding, with a few illustrations, will be given in this article, as a specific description of the many styles would occupy too much space.

Fig. 1 gives a view of a form for winding coils that have no spools. The shape of this form depends on the style of the coil to be wound. The form is clamped to a lathe faceplate either by bolts extending through the form or through the side *b*. Dowel pins *c* and *c'* serve to hold the side *b'* from twisting, and the bolt *d* and the nut *e* hold the whole form together securely.

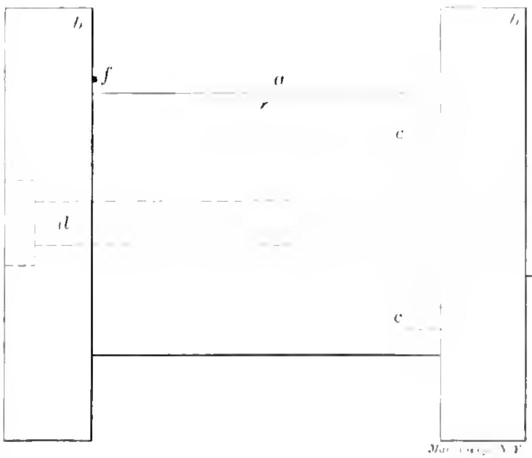


Fig. 1.

Fig. 2 represents a guide that is held in the toolpost of a lathe. Attached to the piece *a* is a grooved wheel, *b*, over which the wire from the reel runs. The same arrangement of reels can be employed in winding field coils that is used with armature coils.

Fig. 3 shows front and side views of a connector, which consists of a piece of sheet copper, *b*, rolled up at the end, *c*, and sweated into a sleeve, *a*, at the opposite end. The sleeve has a setscrew, *d*, for outside connections on the machine.

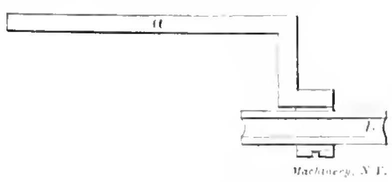


Fig. 2.

A very convenient way of securing the last turn of wire is shown in Fig. 4. Here *a*, *b*, *c*, *d* and *e* represent the convolutions of wire; *f* is a loop of cotton tape with its ends protruding at *g*. The loop is laid on the coil before the turns *c* and *d* are made, then the end of the wire, *h*, is pushed through, and the loop *f* is drawn tight by pulling on the ends at *g*.

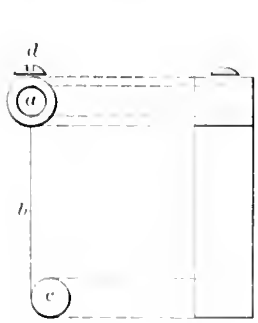


Fig. 3

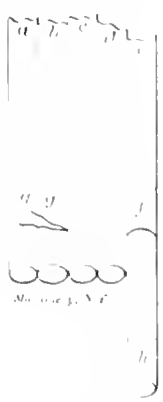


Fig. 4

We will now start to wind a coil. First, bolt the form to the faceplate of the lathe, then arrange the reel conveniently for paying off the wire. Solder a connector like that shown in Fig. 3 to the end of the wire, and tape thoroughly. Catch the connector behind the pin *f*, provided for that purpose (Fig. 1), and proceed to wind. The wire running over a guide wheel on the toolpost enables the operator to use the tool [illegible] guiding the wire as it is wound. With a little practice [illegible] ator will be able to run the tool carriage backward and for[illegible] with enough skill to permit considerable speed in winding.

The connectors can be made in different lengths and widths for varying styles of coils. The connector for the outer end of coil will, of course, be short, allowing the sleeve *a* to come on outside of insulation. Having wound the desired number of turns onto form, finish the end with a loop of tape, as shown in Fig. 1, and solder on outside connector.

Coils wound of wire fine enough to be flexible do not require connectors, as the wire itself may be left protruding through the covering. Before starting the winding, several pieces of cord or cotton tape must be laid across the form, with ends long enough to tie over the completed coil. Having completed the winding of coil, take off the side of form *b'*, and remove the coil.

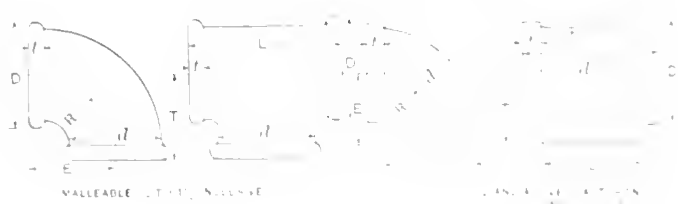
Different manufacturers have various methods of insulating their coils, and it is always well to treat the new coil in the same manner that the original coil was covered.

* * *

The impossible appears to have been accomplished in the maintenance of a clear fresh atmosphere in an office building in the heart of the Pittsburg mill district. This result has been secured in the case of the office building of the H. K. Porter Co., by the introduction of the special plenum heating system and coke air washing apparatus. The entire equipment was designed and installed by the B. F. Sturtevant Co. of Boston, through its local Pittsburg office. The heating apparatus consisting of fan, heater and belted motor, is installed in the basement in conjunction with the washer which consists of a metal supporting frame filled with broken coke over which water is allowed to trickle. The air as it passes between the fragments of coke is thoroughly cleansed of smoke and dust, which is washed down by the water to the bottom of the device and there removed. Previously to the installation of this plant, drawings, papers and the like became very dirty. It is now reported that they are kept perfectly clean at all times, owing to the fact that no air can go into the building except through the heating apparatus, where it is very thoroughly and effectively cleansed. The slight pressure maintained within the building causes outward leakage at all points. It is anticipated that the same equipment will prove very advantageous for ventilating purposes during the summer time.

* * *

DIMENSIONS OF ELLS AND TEES FOR WROUGHT IRON PIPE.



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Contributed by W. I. Ma[illegible], Pittsburg, [illegible]

PROPORTIONS AND CHARACTER OF SAND AND GRAVEL TO USE IN CONCRETE.*

The terms gravel and sand are a trifle indefinite and obscure. Sand, the grains of which are above a certain size, is called gravel, and there is no distinct line of demarcation between these two, one gradually shading into the other. For convenience we will say that all of the mixture which will pass through a No. 10 sieve is sand, while that which will not shall be called gravel.

The relative proportions of sand and gravel in concrete can only be fixed after careful tests of the material to be used. The writer's experience has been that gravel taken from different sources varies so much in size, that the proportion of sand to be added to make a good concrete would have to be determined in each instance. It would, therefore, appear to be impossible to make a definite specification that would cover the proportion of sand and gravel taken from different localities. In order to obtain the correct proportions to be used, the material in question should be screened, separating gravel from the sand, and the proportions of voids determined in each.

Good authorities state that loose gravel of ¾-inch diameter and under contains about 33 1-3 per cent of voids, which is reduced to 21 per cent by ramming. Ordinary loose sand contains about 38 per cent of voids, which is reduced to 21 per cent by ramming.

From the above it can be seen that one part of sand will fill the voids in three parts of gravel of the size mentioned. That is a mixture of 1:3. The per cent of voids increases somewhat with an increase in the size of the gravel, which would correspondingly decrease the above ratio. The gravel should be of different sizes, varying from coarse to fine, screened or washed entirely free from clay, loam, or other foreign matter, and be free from scale, slime or humus.

Gravel sufficiently clean can often be obtained from river beds or gravel bars, but rarely in gravel banks. Gravel can readily be cleaned by sluicing. Sufficient water should be used to carry away all objectionable matter, including fine sand. By using a good sluicing plant, the writer has washed out an excellent quality of gravel from banks containing a large percentage of clay.

The sand should be clean and sharp—preferably coarse and fine mixed—and entirely free from all foreign matter. Several authorities cite laboratory experiments to prove that a percentage of loam is not objectionable. However, the writer would not favor using other than clean sand in actual work.

During the past three years we have used, approximately, the following proportions with satisfactory results: For concrete in arches and girders, cement 1 measure, sand 1½ measures, gravel 4½ measures. In piers and abutments, cement 1 measure, sand 2 measures, gravel 6 measures. In spandrels and retaining walls, cement 1 measure, sand 2 measures, gravel 5 measures. For copings and parapet walls, cement 1 measure, coarse and fine sand mixed 3 measures. The work has shown no surface cracks, or spider-webs. The writer's experience would indicate that more cement is required in gravel concrete than in same volume when broken stone is used. We believe that 10 per cent is about the amount of extra cement that should be used in gravel concrete over and above that required with broken stone.

There is no question in the writer's mind as to the sufficiency of gravel concrete. In every instance where we have used it, we have found it to compare favorably with concrete made of broken stone. The gravel concrete is denser, and requires less ramming. We have built several concrete-steel girder bridges, of spans varying in length from 8 to 25 feet. In these we have used gravel and sand concrete, with gratifying results. The mixtures have been as specified above, and we see no good reason why properly proportioned gravel and sand concrete could not be used in constructing arches of any length desired.

* * *

The pins used in the chord system of the new Blackwell's Island Bridge, New York, are nickel steel, 16 inches diameter and 9 feet 5¼ inch long. Each pin weighs 6,050 pounds, and 300 are required in the structure.

* J. H. Marsh, *The Iowa Engineer*, March, 1905.

PRACTICAL DONT'S FOR MACHINISTS.

H. E. WOOD.

Don't say "that's good enough."
Don't turn a reamer backwards.
Don't use a file for a pinch bar.
Don't grind a drill out of center.
Don't borrow tools; buy your own.
Don't try to cover up your mistakes.
Don't let your lathe run and cut air.
Don't be always looking for pay day.
Don't set a lathe tool behind the chip.
Don't file against the scale of cast iron.
Don't grind ditches in the emerywheel.
Don't use a monkeywrench for a hammer.
Don't use a screwdriver for a cold chisel.
Don't be always looking for quitting time.
Don't try to make a finishing cut on scale.
Don't drive a key too hard while fitting it.
Don't use a file without a handle on a lathe.
Don't run any machine with dull tools in it.
Don't run a machine with the belt too loose.
Don't use any more waste than is necessary.
Don't waste time by doing unnecessary work.
Don't grind round corners on the emerywheel.
Don't be too important to do insignificant jobs.
Don't run the point of your drill into the table.
Don't use the tail end of your vise for an anvil.
Don't always have a litter and muss around you.
Don't take off your overalls before quitting time.
Don't use the ways of a lathe for a bench block.
Don't slide rough castings along on a planer bed.
Don't believe that any two men will caliper alike.
Don't make a practice of being late to your work.
Don't cut a bevel gear without taking a central cut.
Don't do "government work" on the company's time.
Don't try to fool your foreman, for you may get left.
Don't use your employer's oil to wash your hands in.
Don't wait until Monday morning to fill your oil can.
Don't stamp steel letters or figures into cast iron scale.
Don't run the point of your lathe tool into the mandrel.
Don't rap the chips out of your file on the lathe shears.
Don't deny spoiling a piece of work if you have done it.
Don't watch for a chance to wash up before quitting time.
Don't look at the head of a chisel when you are chipping.
Don't set a lathe tool below the center for external work.
Don't do any unnecessary hammering on a drill press table.
Don't be too eager to make an impression on your employer.
Don't keep one eye on the boss and the other on your work.
Don't borrow bolts, straps, or clamps, and not return them.
Don't think yourself above asking questions for information.

Don't think that you know more than your foreman, even if you do.

Don't engage in extended conversation during working hours.

Don't be "woolgathering" when you are receiving instructions.

Don't gage the grip on your hammer handle to suit your pay.

Don't bear down on a hacksaw or file on the backward stroke.

Don't use the end of your hammer handle for a driving block.

Don't screw bolts and nuts hard enough to strip their threads.

Don't start a machine without knowing that everything is ready.

Don't screw a bolt into a newly tapped hole without oiling it.

Don't put milling cutters, taps, dies, or any tools away dirty.

Don't use a vise more than a month without oiling the screw collar.

Don't use one mandrel to drive another one out of a piece of work.

Don't wear jewelry on your hands in a machine shop; it is dangerous.

Don't do any hammering on any machine if it can possibly be avoided.

Don't file a piece of work when you can make it to size with a tool.

Don't try to drill a piece of work unless it is properly supported.

Don't throw files, one on top of another into a drawer, or on the bench.

Don't drill a hole unless you know that the drill is properly ground.

Don't hold a tool of any kind on an emery wheel until it gets blue.

Don't fit up a key without trying a straightedge on it occasionally.

Don't ask your neighbor for instructions; go and ask your foreman.

Don't leave your tools laying around after you are through using them.

Don't ream out holes in aluminum without kerosene oil on the reamer.

Don't say that you understand your instructions unless you actually do.

Don't make a piece of work too small and then bend the gage to fit it.

Don't start up a lathe without seeing that the tailstock spindle is locked.

Don't tap a hole and put a bolt in it without cleaning out the chips.

Don't put an arbor or shaft on lathe centers without lubricant on them.

Don't grind on the flat side of an emery wheel; the edge is made to grind on.

Don't ream out a hole in any kind of steel or wrought iron with common machine oil.

Don't work to a caliper that has been set by another man; set it yourself.

Don't start to make a piece unless you first know what you want to make.

Don't leave a machine after running it, without cleaning it up after yourself.

Don't use a new file on rough castings, as a partly worn out one is much better.

Don't true up a flywheel or gear blank to the surface that you are to turn off.

Don't leave too much stock on a piece of work to take off with the finishing cut.

Don't be jealous of your fellow workman if he gets a better class of work than you do.

Don't try a steel gage or an expensive caliper on a shaft while it is running.

Don't grind a lathe tool for cutting brass, the same as you would for cast iron.

Don't cut the teeth in a gear blank unless you know the outside diameter is correct.

Don't think that you are the only one that has troubles; the foreman has his also.

Don't put a mandrel into a newly bored hole without a lubricant of some kind on it.

Don't use any kind of oil but kerosene to start a shaft loose that has begun to cut.

Don't let the point of your drill touch your work and run along without feed on it.

Don't do a job and leave it without cleaning off all the burrs and marks made by yourself.

Don't put a piece of work on centers unless you know that the internal centers are clean.

Don't turn a straightedge cornerwise when testing a piece of work, as it will fool you.

Don't run a machine when any part of it is out of order, without notifying your foreman.

Don't think that you are a machinist just because you have walked under a sign that read "Machine Shop."

Don't consume any more than your time allowance in cleaning up your machine on Saturdays.

Don't bother your foreman with *all* your little troubles, but try to fight them out yourself.

Don't always have some different way to do your w[illegible] the way the foreman tells you to do.

Don't think that a new foreman is not a mechanic because you never saw him do the work.

Don't run a drill an instant after it begins to squeal, but take it out and ascertain the cause.

Don't start up a planer, shaper, or milling machine unless your work is securely fastened down.

Don't try to straighten a shaft on lathe centers, and expect that the centers will run true afterwards.

Don't put a piece of work on lathe centers unless you know that all your centers are at the same angles.

Don't believe that a V-thread will lift as big a load as a square one will, when all other things are equal.

Don't take it for granted that another man's measurement is all right, but go and measure for yourself.

Don't try to take a burr or bruise off from a flat surface with a scraper or the tip end of a file.

Don't think because you have always done a piece of work in one way, that there is no other way to do it.

Don't think because a piece of work has been done in one way for twenty years that it is the correct way.

Don't rub a surface-plate on your work too much at one time; it is bad for both the plate and work.

Don't put enough lead on a surface plate to make it smear when you try it on the surface you are scraping.

Don't take a difficult piece of machinery apart without having each piece marked to show where it goes back.

Don't set the cutting point of a lathe or planer tool any farther out from the tool rest than is absolutely necessary.

Don't stop with an oil channel until you get clear through and out with it, so as to give the air a chance to escape.

Don't put a nice piece of finished work in a vise without using a set of false jaws made from some soft material.

Don't put collars on a milling machine mandrel without being absolutely sure that there is no dirt or chips between them.

Don't touch a piece of work with a file or scraper unless you know what you want to do to it, and what you are doing it for.

Don't finish your job and ask your foreman for another one without putting your tools away and cleaning up the muss you have made.

Don't take a lathe center out of its socket without having a witness mark on it, and put it back again according to the mark.

Don't start up any machine unless you are absolutely sure that your cutting tools are screwed up tight enough so they will not slip.

Don't start polishing a shaft on lathe centers without having it loose enough to allow for the expansion by heat from the polishing process.

Don't stop the feed on a drill in the middle of a piece of work and let the drill run along without backing it off away from the cutting surface.

Don't put any two pieces of machinery together without making absolutely sure that there is no dirt, or chips, or bruises, or anything to prevent the surfaces from coming promptly together.

* * *

A new use of acetylene gas as an explosive is described in a recent report of Consul-General Guenther, Frankfort, Germany. He says that for this purpose carbide of calcium is reduced to small particles and put into a cartridge, consisting of a tin box. In this the carbide lies at the bottom and above it is a partition filled with water. Above this is a vacant space with the electric percussion device. On the side of the cartridge is an iron pin by means of which the partition between the carbide and the water can be perforated. After the drill hole has been completed the cartridge is placed in it and the hole is closed with a wooden stopper. Then the protruding iron pin is dealt a blow, by which the partition is perforated and the water is caused to come in contact with the carbide, whereby acetylene gas is generated. This mixes with the air of the drill hole. After five minutes the gas is ignited by an electric spark. By this method of blasting the rock is said to be not thrown out but rent with innumerable cracks, so that it can be easily removed afterward.

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MACHINERY

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JUNE, 1905.

PAID CIRCULATION FOR MAY, 1905,—21,806 COPIES
Including 600 advertisers' copies, as part of their contracts.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

A reader of MACHINERY has written the editors a friendly criticism: "The radius lathe tool described by one of your correspondents is not new," he says, "for we have used one since Noah made a floating machine shop of the ark." No, the tool is not new, and we doubt whether in the last analysis one in ten of the devices shown month by month in MACHINERY is new, in spite of the fact that we have among our contributors some of the brightest and best mechanics to be found in the machine shops of the country. It is not easy to hit upon things that are strictly new, and in fact, the old and tried devices are usually the best. A good description of such a device with full directions for its design, construction and use may be of more value than a whole paperful of kinks that have not proved their worth. There is a crop of young mechanics coming along each year who need to learn about the old things as well as the new, and however old and familiar a device may be, it is more than likely to be new and interesting to at least a few of the thousands of readers of this publication. Most machinists know all about radius tools to which our friend refers, and have used them; but we believe when a reader has such a tool to design, he will be glad to remember that by turning to a certain page of MACHINERY he will find all the information necessary to enable him to make one, and thus save himself a lot of trouble and time in designing and experimenting.

* * *

THE CRUCIAL TEST OF THE TURBINE.

The steam turbine has proved its worth and made a place for itself and the manufacturers of turbines have not hesitated to acquaint the public with its many good points and advantages. The defects of the turbine, however, are not so easily to be found out. It is well known that things have happened in starting up and running turbines in various parts of the country that the manufacturers would just as soon not advertise in bold-faced type and would be glad to forget if they could. We believe, however, that most of these difficulties are no more than must be expected in establishing any new enterprise and that they are mostly defects which can be overcome. Just which are of this character and which are inherent in the turbine itself can be told only after years of service under varied conditions.

The vital question, it seems to us, is whether the turbine will prove durable. We know what it is capable of doing under shop test, but how about the economy of a turbine which has been in constant operation ten or twenty years? In what condition will the blades be and how many times will the average turbine have to be rebladed during such a period? This we believe to be the crucial test of the turbine, which will determine whether the turbine or reciprocating engine is to hold sway in the power plants of the future.

Some light was thrown on the subject last month by photographs supplied by the Westinghouse Machine Company, showing the present condition of the interior parts of a turbine installed at the Wilmerding plant some five years ago, where it has been in operation 24 hours a day ever since. Blades which have been subjected to the action of steam during this entire period, and most of the time under unfavorable conditions, show practically no erosion or cutting action and indicate that turbines under conditions existing at this plant, at least, are good for a long period of service without deterioration. If this should prove to be the case in other plants as well as this one, an important point will have been demonstrated, viz., that the turbine is an engine which will run with nearly or quite as good economy when old as when new. The steam engine will not do this without occasional repairs, such as reboring the cylinder, refitting the valves, etc., and is furthermore liable to use steam extravagantly through faulty valve setting. More information upon the erosion of turbine blades is needed and needed badly.

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SHOPWORK INSTRUCTION.

The article in this number upon the very successful system of shop training that has been developed at the Worcester (Mass.) Polytechnic Institute will be read with interest by many. A fundamental principle in the instruction of young men at this institute is that comprehensive shop training is desirable and necessary in connection with engineering studies. More time and attention are here given to the subject of shopwork, probably, than at any similar institution. If this meant that more time were spent in teaching the boys to turn out good-looking and accurate reamers, gears, surface plates and whatnot, than is usually given to such work in shop-work courses, and nothing else, we should say the time could be used to better advantage.

But this is not the case. The effort is made to rise above the mere turning out of work of a given quality, since to become dextrous with tools or drawing pen, to the neglect of broader work not so easily learned, is not what tuition fees are paid for. At Worcester they have the student grapple with the commercial side of shopwork, which, it may be added, is also the engineering side. He learns that the time element is just as important as fine finish or accuracy; that certain methods are better than others because they save time; that high-speed steels and heavy machines are useful because they also save time. Just how much time can be saved is a subject for study and requires estimating, planning and laying out work, and extended experiments and investigation, all of which lead at once to studies as important for the student of engineering as any laboratory work that he may be called upon to do. It is just as necessary for an engineer to understand how money can be saved by saving time in the shop, as to know how money can be saved at the coal pile by making certain adjustments in the valve gear of a Corliss engine. One subject is just as scientific as the other, and has just as much to do with engineering, although the shop-work problems have not generally had the same attention as have the so-called laboratory exercises. Why, we do not know, unless supposed to be less scientific.

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The September number of MACHINERY is to be a draftsmen's number. There will be nothing "special" about this number, either in appearance or size, but the editors have on hand, or in prospect, several contributions of unusual value to draftsmen, and these will appear in September, making that an issue which many draftsmen will want to keep for reference. It is probable that some who read this will be glad to assist us in the preparation of this number, and we will ask any who have information or data that would be appreciated by draftsmen to submit the material for our inspection. The contributions must be short, however, and should be marked "For the draftsmen's number."

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The metal calcium has successfully gone through an experimental stage of production similar to that recently passed through by aluminum, and is now being commercially reduced by electrolysis, the process being similar to that now successfully used for aluminum. In this process, as carried on by a German firm, the molten metal is formed at the cathode terminal of an electrolytic chamber. It is thought that the metallic calcium will serve many useful purposes, there being a large demand for the metal in connection with hardened steel. An English contemporary states that the price of calcium per ounce in 1903 was £56, and the same quantity can now be purchased for 1s. 6d., with prospects for further reduction. This great reduction is caused by the success of the new process.

In an article describing the erection of the 5,000-K.W. engine-driven alternators of the New York Subway, by Mr. R. L. Wilson in the *Engineering News*, it is stated that the central portion of the revolving field element is a steel casting weighing 20 tons. It has a bore 37 inches in diameter with a "stepped" fit on the shaft, each step being 8 inches long; a 10-inch space is cored out in the center, making the total length of the hub bearing 42 inches. The allowance for pressure was 0.008 inch but in practice this was found to be slightly excessive, and it was reduced to 0.0065 to 0.007 inch. With the latter allowance the pressure required to force the steel hubs into position on the shafts was from 500 to 600 tons. The shafts are hollow nickel steel forgings, each having a hole 16 inches in diameter running the full length.

Diamond drill borings of great depth have been made on the gold-bearing reefs of the Transvaal. By this method of boring a solid core of rock is removed, in sections, of course, as the boring proceeds, and in this way a fairly accurate knowledge of the rock formation can be obtained throughout the depth of the bore without going to the expense of sinking a shaft. According to the *Mining Reporter* the deepest diamond drill borings are near Johannesburg and Doornkloof, these bores being 5,582 and 5,560 feet deep respectively. A core of 1¾ inch diameter was removed for the greater part of the distance in each case. The Johannesburg hole required nine months for sinking and that at Doornkloof about fourteen months. An interesting feature of this work from our point of view is that American machinery is almost exclusively used for it in the South African field.

The growing use of electricity for heavy railway operations was dwelt upon by Mr. George Westinghouse in an address given during the opening exercises of the American Railway Appliance exhibition held in Washington in connection with the International Railway Congress. He said: "A new era in railway operations has dawned with its many new problems. I refer to the growing use of electricity for the movement of trains. There have already been such demonstrations of the benefits to be derived from the substitution of the electric motor for the steam locomotive that it requires no great prophet to predict the extensive growth of electric traction upon the great railways of the world and the eventual replacement of the steam locomotive. Fortunately, the time element, which is such a controller of events, and the financial problems involved, will ensure gradual development and extension of the use of electricity."

It is said that the municipal authorities of Vienna, Austria, have decided to equip the city's professional fire brigade and the auxiliary volunteer fire brigade entirely with self-propelled vehicles, 53 motor chemical engines having already been ordered to replace horse chemical engines. The cost of the change will be in the neighborhood of $180,000, but it is said it will effect an annual saving of over $15,000. It would seem as though the motor-driven fire engine would be much more efficient in getting to fires than the horse machine and hence should be bound to come into general use. The engine would naturally be propelled by steam if the steam pump is to be retained, but much may be said in favor of an electric machine having a battery equipment and electrically driven pumps. The battery equipment would not need to be great, since the distances covered would be relatively small. The supply for operating the motors would be drawn from stations which might be located at each fire hydrant.

In a paper read by Mr. D. B Morison before the North East Coast Institution of Engineers, attention was particularly directed to the danger of oil in boiler furnaces and to the fact that collapses of furnaces are almost always the direct result of scale or of oil in the feed water particularly the latter. Mr. Morison said that no ordinary furnace fails from lack of strength if clean and covered with clean water; failure is the result of scale or dirty water, and above all of oil, and a very thin smear of it has an effect totally out of proportion to what might be expected. Starting out with a furnace having a factor of safety of five, it is found that this factor rapidly decreases when the temperature exceeds 650 degrees F., vanishing entirely at a red heat. Steam at a pressure of 200 pounds per square inch, for instance, has a temperature of 380 degrees F., and, as stated above, the temperature of 650 degrees F. marks the commencement of loss of tenacity of the steel composing the furnace walls; at 1,200 degrees F. about 75 per cent. of the tenacity of the steel is gone. A clean furnace rubbed over with a very clean coat of mineral oil will at once rise in temperature to over 650 degrees even under a light duty, hence the danger of even very small quantities of oil or grease in boilers. High grade mineral oils do not give near the trouble in marine boiler practice as do low grade oils, which emulsify, and therefore cannot be filtered out of the feed water without chemical treatment.

The argument formerly advanced against the use of forced draft instead of induced draft, that it burns out the grates, seriously injures the boilers, and blows gas and smoke from the fire doors, is now seldom heard. The basis of this opinion originated in the experience of some engineers with plants equipped with fans operated at far above the proper speed. This was the result of installing (through ignorance) a fan too small for the work, and then forcing it above its normal speed in order to secure the desired air volume. As a consequence, instead of creating an ash pit pressure of ¾ to 1¼ inches, which is all that is ordinarily required, the pressure was forced up to even 5 or 10 inches, with the attending objectionable results.

In one instance, the engineer complained of gas discharged from the fire doors with incidental effects, and condemned forced draft in toto, although he was favorably disposed toward induced mechanical draft. Investigation showed that the fan was being operated at about 12 inches water pressure, which at once accounted for all the trouble.

When forced draft is used, the air as it passes from the ash pits to the combustion chamber is greatly reduced in pressure, owing to the resistances of the grates and the fuel. Coincidentally, the stack, even if a short one, tends to produce a partial vacuum in the furnace. As a result it is practically impossible to create under proper conditions more than a slight excess of pressure in the combustion chamber, and this should not be enough to force the gases out at the fire doors.

Accurate knowledge regarding the proper application of the fan blower for this purpose, will readily dissipate any false impressions regarding forced draft.

A new and improved type of storage battery has been developed by Mr. Joseph Bijur, who had as collaborator, Dr. J.

S. C. Wells, of Columbia University. This cell is of the old lead and sulphuric acid type, but one having the plate differently constructed from the old form, the end sought in the construction of this cell being the attainment of a rigid structure, which should be free from any tendency to buckle and which should, at the same time, allow free circulation of the acid and hold the active material so that it could not be displaced. The plate as constructed, consists of a number of small grills which are supported at two opposite ends by being firmly welded to the supporting grid. These grills are cast in molds under pressure, and so are one piece of lead, but for purposes of description they may be compared to a number of flat ribbons of lead, held together by short intermediate cross pieces. The grills so formed are fastened at intermediate points to the terminals, which are welded to the supporting grid, this method of support allowing the grill to expand lengthwise freely.

With this plate, formation chiefly takes place in the rectangular openings of the grill, a large surface area being exposed to the electrolyte, since these openings are small. As these openings are never completely closed by the active material, the acid has access to the interior of the plate. The active material, as formed, wedges itself into the rectangular openings of the grills, expanding the latter into an elliptical shape, and is thus held tightly in place against the lead of the grill. This formation exposes a large surface of the active material which, being always in contact with the electrolyte, is said to permit high rates of charge and discharge without injury to the plate, and with but little polarization. The grills are welded solidly to the grid without the use of solder.

Railway men in the United States are just waking up to the possibilities of other methods of transportation besides the steam locomotive and the electric trolley car. In many parts of the East and West high-speed electric lines have been built parallel to existing steam roads and by reason of more frequent service at lower fares, they have cut into the business of the steam road to such an extent that the running of trains is attended with continual loss. But, on the other hand, the equipment of a high-speed electric railway is very costly and it can only be done where the volume of traffic is considerable. Between the steam railway and the electric railway lies a field for the steam or gasoline motor car. Light railways equipped with motor cars have been in successful operation for some years in Europe, and experiments are now being conducted on the Union Pacific and other railways in this country with a view of developing what might be said to be a lifesaver for the old steam roads.. A steam road can put on motor cars and undoubtedly successfully compete for passenger business with the electric lines which have cut so seriously into their business. At the recent meeting of the International Railway Congress at Washington, the subject was touched upon in the following language: "It may be expected that from now on automobile cars and auto motors hauling trailers will constitute a valuable means of transportation, which on some lines will have a great future. Owing to the saving in the number of employes required, the probable reduction in cost of maintenance, the material reduction in the cost of traction and better utilization of rolling stock, and the smaller extent of station installations required, it will be possible materially to reduce the cost of working lines with little traffic, and will, in the case of other lines, result in a material improvement in the working of some classes of service. Their use will certainly effect a change in the system of operation in the case of a great number of lines, and appears to have a real future before it."

THE GAYLEY DRY AIR BLAST SYSTEM.

Indian and Eastern Engineer, April, 1905.

A very important departure has been made at one of the blast furnaces of the Carnegie Company at Pittsburg, by the addition of a cold storage plant to the blast. Makers of pig-iron are familiar with the fact that it is very difficult to control the output of pig, with changing temperatures and changing weather. Sudden cooling of the metal has been frequently observed, due to no apparent cause, and this has led blast furnace managers to carry higher temperatures than would otherwise be necessary, to meet these sudden calls. Mr. Gayley, the manager of the works in question, has traced the trouble to the varying quantity of watery vapor present in the air that is pumped into the furnace. Records he obtained showed that there was a difference of from 2.18 grains of moisture per cubic foot of air in January to 5.6 in July, and 5.68 in September, and he calculated that this meant that 87 gallons of water were entering the furnace per minute in January, while in July and September over 200 gallons were entering in the same time. And this was not the whole of the trouble. The quantity of watery vapor present varied from hour to hour on the same day by changes of wind, for instance, and from other causes. On the same day the quantity of moisture present in a cubic foot of air varied from 1.96 grains at 8 A. M. to 3.06 at 8 P. M. The trouble has been overcome by drying the air, before it is allowed to enter the hot blast stoves. It will be remembered that combustion is maintained in a blast furnace by the continued pumping of air into the furnace, by a blowing engine, and that the air is heated by a portion of the waste gases from the furnace. An ammonia compression plant has been erected in the neighborhood of the blast engine, the ammonia expansion coils being made to cool brine in a tank, and the brine is taken to a cooling chamber, where it is caused to circulate through pipes arranged for the purpose, and around which the air is made to pass on its way to the hot blast stoves. The air, being cooled, loses a large portion of its ability to carry moisture, and the watery vapor it has carried is deposited upon the cold brine pipes, the air passing on cooled and dried. The moisture freezes upon the brine pipes, and it is arranged to disconnect a portion of them periodically, and to thaw out that section by passing hot brine through the pipes. The water produced is used for the boilers. The drying of the air not only gets rid of the uncertainty mentioned above, but it also adds to the value of the blast. Air which is cooled, as is well known, occupies less space than air which is warm, and as it is oxygen that is wanted in the furnace, and as the air is dealt with in the blowing engine by cubic feet entering its cylinder, the result of the cooling is that a larger quantity of free air, as it is termed, passes into the furnace, and a larger quantity of oxygen. The power required from the blowing engine has been reduced in consequence sufficiently to provide power to drive the ammonia compressor, and in addition the output of the furnace has been raised from an average of 358 tons per day to an average of 447 tons. It must be remembered that the output of the American blast furnaces is larger than that of those in the old country. In fact, the increased output due to drying the air is nearly equal to the output of many furnaces in the United Kingdom. The product of the furnace is also stated to be more uniform and therefore of higher value. There is one point in connection with this that is open to criticism. The arrangement for cooling the air is not the best, nor the latest. Cooling the air is largely practised in a modern refrigerating plant, but the action is made quite continuous. It would never do to have to lay off part of the apparatus to clear off the ice. The usual plan now adopted is to drive the air between a battery of galvanized iron plates, over which the cooled brine is constantly trickling.

NIAGARA WATER POWER.

William C. Unwin, F. R. S., in the Engineering Supplement, London Times.

At the present time, when in this country large schemes for the distribution of power are being carried out or are being projected, it may be opportune to give some account of the progress of power distribution at Niagara.

If all the water flowing down the Niagara Gorge and all the fall could be utilized, then in average conditions about 7,000,000 horse power would be available. But, though the outflow from the great lakes is singularly uniform, there is a variation in flow, and part of the fall must be wasted to obviate engineering works of too costly a character. The value of such a source of energy was perceived long ago. In 1861 a small canal was constructed, 35 feet wide by 8 feet deep, from above the upper cataracts to the top of the bluff

below the falls. At the edge of the bluff mills were erected with turbines driven by water from the canal. Later the State reservations were formed on both sides of the river to preserve the natural beauties of the falls, and this to some extent hindered efforts to increase the water power. In 1886 Mr. Evershed obtained a charter for utilizing power about a mile above the falls, the tail water being carried away by a tunnel and discharged inconspicuously into the lower river. But it was not till the discovery of electrical methods of distribution that Mr. Evershed's scheme became commercially practicable.

In 1890, the Cataract Construction Company was formed, with the object of developing 100,000 horsepower and with the right to utilize 100,000 horsepower more, though, at that time, it required great boldness and faith in the progress of electrical methods to expect that such a block of power could be distributed, over a sufficient area, without too great enhancement of cost. However, the two power houses of what is now the Niagara Falls Power Company on the American side have been completed, 105,000 horsepower of turbines are installed, and about 75,000 horsepower is regularly delivered partly near Niagara Falls, partly at Buffalo, $22\frac{1}{2}$ miles distant, and at Tonowanda and Lockport.

An essential condition of the success achieved by the Niagara Power Company was the adoption, after prolonged discussion, of the system of distributing two-phase current with low periodicity, for this system lends itself to the most varied applications. In the two power houses the generating units are all identical, and any unit can be put on any service, the current from all the generators being two-phase current, at 2,200 volts, with a periodicity of 25. With such a current the voltage can be changed in the easiest and cheapest way by static transformers, single-phase current can be supplied if required, and direct current may be obtained without much increase of costly rotary converters. Thus, from the Niagara Power Company's station direct current is supplied for lighting; low tension direct current for electrolytic work, as for making caustic soda, bleaching powder, sodium; direct current for trolley tramways; and single-phase current for heating in electro-metallurgical processes. When the transmission to Buffalo was considered, it was found that there would be a saving of copper with a three-phase current, and a method was found of transforming the two-phase current to three-phase. The transmission to Buffalo is three-phase current at 22,000 volts. It is not generally realized in this country, how unsuitable the electric systems adopted in lighting stations are for a varied application of current for lighting, power, electro-chemical processes, and long distance transmission. The system at Niagara satisfies all requirements. The cost of transformation when it can be done on a large scale is very moderate.

Very early the Niagara Power Company obtained rights on the Canadian side, but action was postponed till experience had been gained with the plant on the American side. Now a power house is in course of construction immediately above the falls on the Canadian side, with a short tail-race tunnel. This power house is to have 11 units of 12,500 horsepower each, of which five are already installed. Three-phase current at 11,000 volts and 25 periods is generated, and connection is to be made to the power house on the other side, so that they may be able to help each other if necessary. Arrangements are being made to transmit 20,000 horsepower, probably at 60,000 volts, to Toronto, a distance of 85 miles, pending the completion of the works next to be described.

A second installation of 125,000 horsepower on the Canadian side is being constructed by the Toronto and Niagara Power Company. The current generated will be 12,000 volts, with 25 periods. A remarkable feature of this plant is that the tail-race tunnel passes right under the upper cataracts and discharges under the center of the Horseshoe Falls. The head works are remarkable for the boldness with which a cribwork dam of great length was built in the upper cataracts. The plans of the Niagara Power Company and the Toronto and Niagara Company are, from the engineering point of view, very similar.

A third company, the Ontario Power Company, is also constructing works for utilizing 180,000 horsepower on the Canadian side. Their plans are different. The water ... from a point above the intakes of the other companies ... conveyed in steel pipes 18 feet in diameter, to the edge ... the cliff below the falls, thence the water is dropped in 9-foot pipes to a power house in the gorge below the falls. One of the large pipes supplying water for 60,000 horsepower is already constructed. Here also three-phase current of 12,000 volts and 25 periods will be generated.

Meanwhile the owners of the old hydraulic canal on the American side have been stimulated to increase the development of power on somewhat analogous lines to those they first adopted. The old canal has been successively enlarged. In 1881 they constructed a station for 1,500 horsepower, and in 1896 a station for 34,000 horsepower. They are now carrying out an installation for 100,000 horsepower.

The total utilization of power therefore now projected amounts to 650,000 horsepower. The whole of the machinery for this development may not be erected for some time, but that great confidence is felt that it will be required may be inferred from the fact that the very costly headworks, wheel pits, and tail races are being projected for the full projected amount of power. The cost at which electricity is supplied is believed to be about £3 10s. per horsepower at Niagara and £7 10s. at Buffalo. This is for power supplied, if required, for 24 hours. At Buffalo the cost is probably not very much below that of steam power to ordinary large users who do not require 24-hour power. But it is in many respects more convenient than steam power.

The mean flow of the Niagara River is about 222,000 cubic feet per second. Suppose, what is about true, that 150,000 horsepower are now daily utilized, that the mean available fall is 160 feet, and that the efficiency of the turbines is 0.75. Then the daily demand for water is 11,017 cubic feet per second, which is 5 per cent of the mean flow, or $6\frac{3}{4}$ per cent of the *minimum* flow. But if 650,000 horsepower are utilized the demand for water will be 17,740 cubic feet per second, or $21\frac{1}{2}$ per cent of the mean flow and 30 per cent of the *minimum* flow. Obviously, if no alteration of the appearance of the falls is at present perceptible, the alteration is likely in the future to be very considerable, especially as the depth of water over the American fall is very small.

DESIGN AND OPERATION OF THE SUCTION GAS PRODUCER.

R. Mathot, Engineering Magazine, May 1905.

The early gas engines were designed for the use of illuminating gas, but the high cost of this fuel has led to the designing of various forms of apparatus for the production of a cheaper fuel, in which the various types of gas producers have attained considerable success. The first type of producer built, the pressure gas producer, required a separate steam boiler to operate the steam jet for delivering steam below the grate, this being done for the purpose of enriching the gas with the dissociated hydrogen of the steam as it passes through the incandescent coal bed. Also, as there is pressure beneath the grate it is necessary to have some form of water seal or tight joint at the bottom while the entire apparatus has to be made gas tight. A gas holder is also required since the production of gas is independent of the operation of the gas engine to which it is supplied.

In modern gas engines of both the 4-cycle and the 2-cycle types, one of the outward strokes is a suction stroke, this suction being employed to draw in the mixed charge of gas and air. In the suction gas producer this suction stroke of the engine draws the air through the coal bed instead of having it impelled by pressure. This substitution of suction for pressure not only dispenses with the separate blowing set but also causes a pressure slightly below the atmosphere to be maintained in the whole apparatus, so that there can be no leaks and there is no necessity for sealing the ashpit. The separately fired boiler, also, is replaced by what is termed a vaporizer. This consists of a vessel containing water raised by the heat of the gas nearly up to the boiling point, the vapor thus formed being delivered under the grate and sucked up through the coal bed with the air by the engine. The supply is automatically controlled by the demand in this producer, the produc-

tion of gas ceasing when the engine is stopped, and increasing when the speed of the engine is increased; hence there is no need of a gas holder. The general arrangement of the suction producer plant is given by Fig. 2, in which *A* is the producer, *B* the evaporator, *C* the scrubber, *D* the pressure equalizer, and *E* the engine. A sectional view of a suction producer is given in Fig. 1.

At first, that is four or five years ago, the designers of such apparatus tended to construct producers of too large dimensions. The result of this practice was to produce an abundant volume of gas; but this was of a poor quality because the temperature of combustion was kept too low. It must be remembered that the hydrogen, resulting from the dissociation of the water contained in a state of vapor in the air fed into the furnace, is the chief element which enriches the gas. The supply of air is a function of the dimensions of the machine, while the velocity of the air current increases as the area of the grate is reduced. The dissociation of the greatest amount of water is only made possible by a considerable velocity of the draft passing through the fire. It has been demonstrated that the greatest production of hydrogen and most effective reduction of dioxide to monoxide is with a producer, the cross section of the base of which varies between 0.6 and 0.9 times the area of the piston of the engine producing the suction. This applies to the simple 4-cycle engine running at a piston speed of 600 to 800 feet per minute. The depth of combustible in the upper part of the producer retort should be 2 to 5 times the diameter of the base for lean coals in sizes from ½ to ¾-inch lumps.

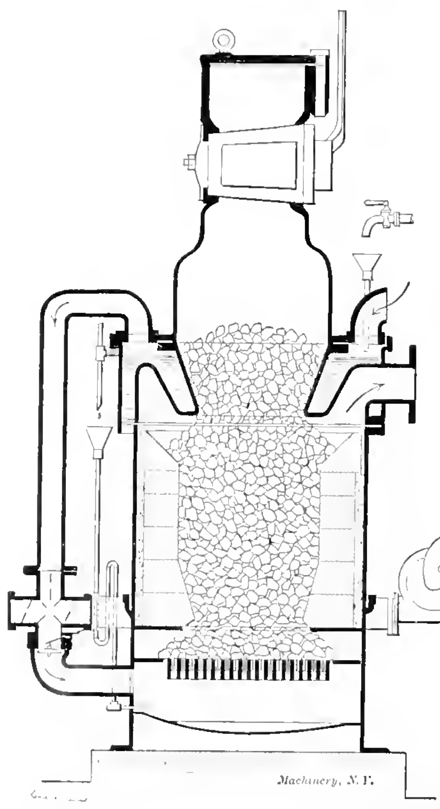


Fig. 1. A Sectional View of a Suction Gas Producer.

The composition of gas produced by various systems of suction gas producers averages as follows:

Carbon monoxide	24 per cent.
Carbon dioxide	5 per cent.
Hydrogen	17 per cent.
Nitrogen	54 per cent.

In selecting a fuel the lumps should range from ½ to 1¼ inches in diameter and the coal should be as free from dust as possible and contain not more than 8 or 10 per cent of ash in order that the grate may not be obstructed. The volatile matter must not be over 8 to 10 per cent and the coal must not coke or swell during the combustion, otherwise arches will be formed, impeding the natural descent of the fuel. Further to prevent this danger, the producer must be provided with poke-ing holes so that the fire may be stirred without admitting air. Coals containing sulphur or producing much tar should be avoided. If an excess of air enters the producer through the grate it interferes with the distillation of gas by cooling the zone of combustion and checking the formation of steam. If air enters above the fuel it dilutes the gas and may produce dangerous explosive mixtures. Hence all parts of the apparatus, including vaporizers, scrubbers, etc., should be tightly closed.

The preference is at present given to producers equipped with the internally heated vaporizer. Externally fired vaporizers, however, constructed with tubes having thin walls and a large amount of heating surface, heat the water more quickly and produce sufficient vapor to enrich the gas in from 10 to 13 minutes after starting the fire. With a well-designed tubular

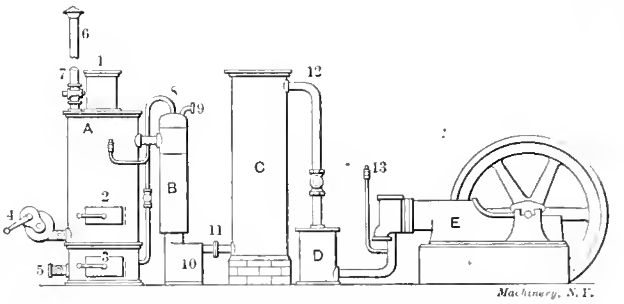


Fig. 2. General Arrangement of a Suction Producer Plant 1, Coal Hopper with Gas Lock; 2, Cleaning Door; 3, Ash-pit Door; 4, Hand Blower, for starting; 5, Air Valve; 6, Escape Pipe; 7, Outlet Valve—these for use when the Gas Engine is not running. 8, Pipe conveying Steam from Vaporizer to Ash Pit; 9, Air Inlet to Vaporizer; 10, Water Box; 11, Gas Connection to Scrubber; 12, Gas Outlet from Scrubber; 13, Test Valve for Sampling Gas at Engine.

vaporizer the producer and motor should be running at full power in 25 minutes after lighting up. Tubes of brass or copper should not be used in tubular vaporizers, as ammonia and sulphur corrode them. The scrubber, in accordance with good practice, is made six or eight times the volume of the producer, the height being three to four times its diameter. The best filling for the scrubber is metallurgical coke in lumps of three to four inches diameter. For washing the gas from three to five gallons pure water per horse power hour are required when the fuel is anthracite.

The above principles apply equally well to producers which supply motors of 10 horse power as to those of 150 to 200 horse power engines. Tests made upon a Körting suction producer and engine plant of only 6 horse power, gave a gross fuel consumption of 1.126 pounds of anthracite per effective horse-power hour. Complete tests made upon a double-acting Otto-Deutz engine and producer of 200 horse power gave the low consumption of 0.722 pounds of coal for an effective horse-power hour.

PHENOMENA OF MACHINE OPERATION.

John Richards, Journal of the Association of Engineering Societies, March, 1905.

The purpose of this paper is to call attention to the fact that the conditions of actual practice are often best met, not by machines figured out and determined from a drafting board from scientific data, but rather by such as have come to us through evolution and have been developed mainly by other means than computation.

In static structures, that do not involve machine motion, or that branch of constructive work we commonly call civil engineering, there is a close relation with science; means and agents are becoming uniform and can be computed, and results predicted, with much certainty. Strains can be defined; the properties of material are ascertainable; and extraneous forces, such as stress of the elements, the stability, oxidation and decay of material, and even its deterioration by fatigue, are becoming known and computable. In machine operation, however, the path is by no means so clear and perhaps never can be. Nevertheless, some of the general phenomena of operation are becoming susceptible of computation and scientific treatment; but, as I believe, to a much less extent than is generally assumed and believed.

The development of turbine water wheels may be taken as an example of the lack of real insight into the phenomena of machine operation. Such wheels were made the subject of research by eminent French engineers of the middle of the past century. These men, commissioned by their government, laid

down scientific rules to govern the construction of these wheels, and produced the three types of turbine water wheels known as the outward flow, the Jonval or parallel flow, and the impulse wheels of Girard. About 1850, two American engineers constructed at Lowell, Mass., what have remained, up to the present time, the finest example of outward flow turbines on this continent. The other types mentioned were later introduced into America. Here was a complete mathematical development of water turbines carried out to operate at the greatest efficiency. The subject of the water seemed ended, as in fact it had been so far as efficiency was concerned, but there was another phase to be dealt with in the operating conditions.

The French turbines were refined machines, expensive, and adapted for pure water. Gravel, driftwood, and other debris would not pass through the fine issues of the turbines, hence the latter were not well adapted to American conditions. Our American mechanics then began in an experimental way, whittling out new models. In the French wheels, the running expensive elements were outside, and occupied the extreme diameter, while the rough and inexpensive fixed elements were placed internally and were of relatively small diameter; the result in construction being expensive and requiring a slow rate of revolution with a strong and expensive transmission gear. Engineers, however, were so accustomed to associate centrifugal effect with turbines, that radial or outward flow seemed an essential condition; in fact, it had little to do with the case, as was found out by later experiment.

The American mechanics, after many years of "whittling" out models, succeeded in turning the wheels "inside out," or inverted them, so to speak, making the internal or smaller elements the running part, so that the water flowed inward toward the center, then changed its course 90 degrees downward in helical passages for escape. This was done entirely without scientific aid, in some cases even controverting scientific rules, and the result is the centripetal or inward flow turbine, the standard water wheel of this country, of which a single firm has made more than 10,000, and the wheels have even found their way back to France. Their efficiency is fully equal to, or even greater than, that of the older types, and the cost of the wheels is about one-half as great. This evolution has required about sixty years, and present practice rests mainly upon observed phenomena and upon the operating conditions rather than upon computed data. There was not even a draftsman in the works where the wheels were made that gained the highest award at the careful trials conducted at the Centennial Exposition, in 1876.

In the case of elastic fluids, impulse motors or steam turbines have been more than a century in evolution, notwithstanding that more than 400 patents have been granted in Great Britain alone for inventions pertaining to these machines, some of them a century ago and many of them fifty years ago. Mr. Parsons, who has been prominent in this work during later years, is, no doubt, one of the greatest living adepts in the science of thermodynamics, and, as is claimed, he has forecast with much accuracy the development of his turbine schemes as they progressed from 18 down to 11 pounds of steam for each horse power hour, but it is also claimed that he has expended half a million dollars in experiments. If inquiry were made, Mr. Parsons would probably admit that not one-fourth of his data came from computed sources, and that the observed phenomena of operation and adaptation have comprised the other three-fourths.

A wider and more important example of evolution in operating phenomena is furnished by piston steam engines. I do not mean the thermodynamic development of these, which is the greater part, furnished mainly by scientific deduction and experiment, but to the mechanical evolution of their operating parts, which had to keep pace with the thermal problems.

Down to twenty-five years ago it was a common object, in steam engine design, to reduce surface and velocity in bearings, partly to avoid friction, and partly because reduction of weight and space were also incentives, but the operating phenomena of machine bearings was a mystery in so far as any scientific rules were available.

Alignment, or the fit of bearing surfaces, especially in the case of cranks, is yet a mystery, if considered in a practical way. The most careful computations, respecting the flexure of shafts, frames, crank disks and pins, fail to [illegible] operating phenomena. One has only to observe the [illegible] an overhung crank or disk, even of the strongest [illegible] to see that it describes a visible ellipse when under heavy strain and for reasons not explainable by computation. Similarly obscure operating conditions exist in various other parts of steam engines, and proportions are, beyond question, based more upon observed operating phenomena than upon computed dimensions.

Bearings that operate under steam, slide valves for example, were scraped to a perfect fit; cylinders were bored out with a smooth, glistening surface under a belief that such fitting was theoretically correct, but, by accident mainly, it was found that the bearing surfaces performed much better when they were not smooth and in perfect contact. A film of interposed water or oil produced the uniform fit.

In crushing hard material, such as quartz, with metallic surfaces, it was naturally inferred that the metal opposed to the stone should be as hard as possible, but, for reasons not easy to explain, soft metal endures longest. Cornish rollers are now covered with rings or tires of soft, fibrous iron. The sand blast discloses a like phenomenon. It is easier to bore a hole through a file with the sand jet than through a thin sheet of copper. An emery wheel will rapidly cut away tempered steel, but not soft iron. It is a problem of friability, no doubt, but is not fully explained. The whole field of mechanics is full of unexplained phenomena and mysteries, such as the temper of steel, the fatigue of metals, their crystallization under rhythmic concussion, the inherent strains in molded steel, the surge and reaction of moving liquids under high pressure.

Much that is written is apt to lead to the conclusion that scientific calculation alone suffices, in machine design, without the exercise of logical reasoning and practical observation of the operating phenomena and the conditions of use. Academic institutions should, at least, temper their theoretical instructions with the required warning that the phenomena of the operation of machines must be a principal factor in their successful evolution.

BELTING.

American Engineer and Railway Journal, May, 1905.

The following notes are abstracted from a set of belting instructions compiled by Mr. F. M. Whyte, general mechanical engineer of the New York Central Lines, and issued for use in the shops by Mr. R. T. Shea.

It is desirable to locate the machinery so that the belts shall run off from each shaft in opposite directions, as this arrangement will relieve the bearings from the increased friction that would result were the belts all to pull the same way. Two shafts connected by a belt should never be placed one directly over the other if possible to avoid it, as in such a case the belt must be kept very tight to do the work. It is desirable that the angle of the belt with the floor should not exceed 45 degrees. If possible the machinery should be so placed that the direction of the belt motion shall be from the top of the driving to the top of the driven pulley. The faces of pulleys should be about 25 per cent. wider than their belts. When practicable, belts should be tightened by moving one pulley away from the other.

The ability of a belt to transmit power depends upon the tension under which it is run, the degree of friction between the belt and the pulley, the complete contact of the belt with the pulley, the speed of the belt, and the arc of the pulley in contact with the belt. The tensile strength of single, ordinary tanned leather belting is about 4000 pounds per square inch. The working strain should not exceed 10 per cent. of its tensile strength. The average leather belt will not transmit a force equal to its strength for the reason that it will slip on its pulley before it will break.

As the friction of leather on leather is five times as great as that of leather on iron, the adhesion between the belt and the pulley can be greatly increased by covering the pulley with leather. The belt is thus capable of doing more work for a given width, the belt tension can be lessened to get the necessary friction, thus adding to the life of the belt, and unnecessary wear of the belt and a wasteful loss of power due to its

slipping on the pulley are prevented. The strain to be allowed for all widths of belting—single, light double and heavy double—is in direct proportion to the thickness of the belt, firmness of the leather being the same in all cases. Avoid running belts too tight, as great tension shortens the life of the belt, occasions a waste of power and causes great inconvenience from hot boxes, broken pulleys, and "sprung" shafting. Belts, like gears, have a pitch line, or a circumference of uniform motion. This circumference is within the thickness of the belt, and must be considered, if pulleys vary greatly in diameter and a required speed be necessary.

Belts are more satisfactory made narrow and thick, rather than wide and thin. Thin belts should not be run at a high speed nor wide belts be made thin. Such almost invariably run in waves on the slack side, or travel from side to side of the pulley, especially if the load changes suddenly. This waving and snapping wears the belts very fast; it is greatly obviated by the use of a suitable thickness in the belts. For new belts those that have already been filled with some good waterproof dressing are preferable to "dry" belts, for if not so filled they soon will be, with lubricating oil and water, a combination that will ruin any belt. Rubber belts should be used in places exposed to the weather, as they do not absorb moisture, nor so readily stretch or decay as leather belts under like circumstances. A new belt should be made straight, and if so made will run absolutely straight if the pulleys are in line. Slots punched in the center of a belt allow a chance for the air to escape between the belt and the pulley, and prevent "air cushion"; this is of particular advantage in all belts running at high speed.

It is safe and advisable to use a double belt on a pulley 12 inches in diameter, or larger. Light double belting runs steadily, with a minimum of "snap" or vibration, and does not twist out of place like single belting. It is successfully used for counter belts where shifters are used and where the work is not sufficiently hard to demand a heavy double belt; it is especially adapted for use on cone or flange pulleys, as it will keep its place and is less liable to turn over, and at the same time is pliable enough to hug the pulleys like a single belt. Double belting, light or heavy, is not recommended for twist belts at high speed, nor for wood work where belts are exposed to a large amount of chips or shavings, nor for places where much oil or water are liable to get on it.

As a means of making necessary alterations in the length of a belt the laced joint is recommended. To lace a belt, cut the ends perfectly true with the aid of a try-square. Punch the holes exactly opposite each other in the two ends. The grain (hair) side of belt should be run next to the pulley, and the belt should run off, not on to the laps. For belts 1 inch to $2\frac{1}{4}$ inches wide use $\frac{1}{4}$-inch lacing; $2\frac{1}{2}$ inches to $4\frac{1}{2}$ inches wide, use 5/16-inch lacing; 5 inches to 12 inches wide, use $\frac{3}{8}$-inch lacing. For wider belts use wider lacing. Avoid thick lacing. In punching a belt for the lacing, it is desirable to use an oval punch, the longer diameter of the punch being parallel with the belt, so as to cut off as little of the leather as possible. There should be in each end of the belt two rows of holes staggered. Holes should be as small as possible. Recommended number of holes in the belt end for various widths are as follows:

Width in inches....	2	$2\frac{1}{2}$	3	4	5	6	8	10	12
Number of holes...	3	4		5	7	9	11	15	19	23

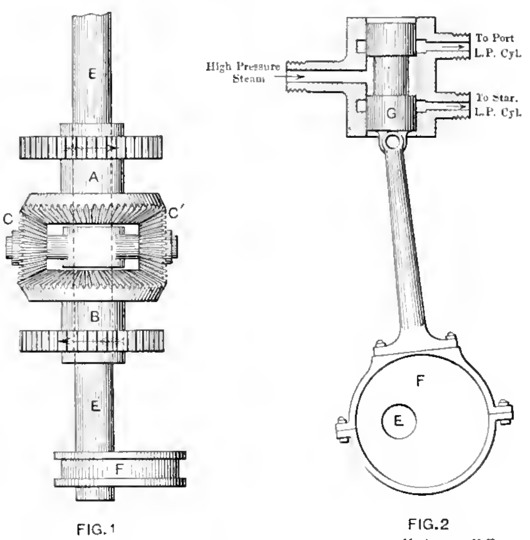
The edge of any hole should not come nearer to side of the belt than $\frac{5}{8}$ inch, nor nearer the end than $\frac{7}{8}$ inch. The second row should be at least $1\frac{3}{4}$ inches from the end of the belt. On wide belts these distances should be even a little greater. Begin to lace in the center of belt, and take much care to keep the ends exactly in line, and to lace both the sides with equal tightness. The lacing should not be crossed on the side of the belt that runs next to the pulley.

Belts and pulleys should be kept clean and free from accumulations of dust and grease, and particularly lubricating oils, some of which permanently injure the leather. They should be well protected against water, and even moisture, unless especially waterproofed. Resin should not be used to prevent belts from slipping. If a belt slips see first that the pulley is not dirty. Clean all the dirt from it and from the belt; rub the pulley surface of the belt with a dressing composed of 2 parts of tallow and 1 part of fish oil, rendered and allowed to cool before using. This will soften a belt and also preserve it, and it will not build up on the pulley and cause the belt to run to one side. If the belt then slips it is overloaded, and the remedy lies in a leather-covered pulley, a wider belt or a larger pulley.

A METHOD OF PREVENTING VIBRATION IN STEAMSHIPS.

From Paper by A. Mallock, Institution of Naval Architects, May, 1905.

In twin-screw ships, no matter how much the engines individually are out of balance, freedom from vibration in the ship can be secured if the engines are constrained to run at the same speed and in opposite phase to one another. I have often, in reports on such subjects, referred to the complete absence of vibration in twin-screw vessels, when the phases of the engine are opposed, as an illustration of the fact that properly applied balance weights would prevent vibration altogether; for in this case the moving parts of each engine act as balance weights to the other, and if any method could be found of keeping the relative phase of the two engines constant no other balancing would be required. Of course, it is impracticable to connect the engines by gearing or any equivalent mechanical device. Any connection between the two engines, if the method is to be a practical success, must be applicable at will and capable of being removed with ease without stopping the engines or interfering in any way with their separate working when removed.



A Marine Engine Governor to Prevent Vibration in Steamships.

All this might be done with a governor of the form suggested diagrammatically in Figs. 1 and 2. A and B and C C_1 are a set of differential wheels, of which A is driven by the port and B by the starboard engine. The axes of the intermediate wheels C C_1 are fixed to the shaft E, which carries the eccentric F from which the valve G is worked. As long as A and B revolve at the same speed the shaft E remains stationary, but it rotates if the speeds of A and B differ. The valve at G is made so that if the shaft E, with its eccentric F, moves in either direction from some assigned position, owing to a difference of speed between A and B, high-pressure steam is admitted to the low-pressure cylinder of the engine which has the lesser speed until the valve and eccentric resume their original position. The steam pipes required for this purpose would be very small. By cutting off the steam supply to G the governor would cease to operate, and the engines would then be absolutely independent.

I have had a recent experience, on one of the largest of the Cape liners, of how annoying an intermittent vibration can be. In the ship in question the vibration was horizontal, and the engines were generally running at speeds differing by something less than a revolution per minute. Thus during intervals of rather more than a minute the vibration would cease and again rise to a maximum, and while being kept awake from this cause I had plenty of time to think if no remedy could be found less drastic than altering the engines them-

selves. I believe that the plan now sketched would be effective, and the cost, even for the largest ship, would be reckoned in hundreds rather than in thousands of pounds.

GAS PRODUCER POWER PLANTS.

Paper by Samuel S. Wyer, Meeting American Institute Mining Engineers, at Washington, D. C., May, 1905.

The fact that gas producer power plants have received so little attention in America may be attributed to five conditions: (1) Ignorance and prejudice, (2) newness of work, (3) inadaptability of gas engines, (4) fuel economy not imperative, (5) smoke nuisance not given attention.

1. The only literature pertaining to gas producer power plants is that found in the various technical journals and in the transactions of engineering and other technical societies. In many cases the papers are of a fragmentary character, and seldom are they complete or comprehensive. It may be that the lack of reliable data available to engineers is the cause of the ignorance and prejudice that exists concerning this important branch of engineering.

2. The manufacture of producer gas is an old process, and gas engines have been developed to a very high stage of mechanical efficiency, hence there is no valid reason why such installations should be regarded as experimental.

The Winchester Repeating Arms Company, at its plant in New Haven, Conn., has a Loomis-Pettibone gas producer plant, built primarily to furnish gas for fuel purposes (such as for annealing ovens, furnaces, etc.); a 100-horsepower Westinghouse gas engine was installed some time ago, and later three direct-connected units, each of 175 horsepower, have been ordered. At the present time this example is one of the best instances in America of an industrial producer gas plant where gas is furnished both for fuel and for power.

The following list comprises some of the larger gas producer power plants now in operation in America:

Moctezuma Copper Co., Nacozari, Sonora, Mexico.

Guggenheim Exploration Co., 700 horsepower, Santa Barbara, Chihuahua, Mexico.

Detroit Copper Mining Co., 1,000 horsepower, Morenci, Ariz.

Rockland Electric Co., 1,000 horsepower, Hillburn N. Y.

Potosina Electric Co., 600 horsepower, San Luis Potosi, Mexico.

Velardeña Mining & Smelting Co., 2,000 horsepower, Velardeña, Durango, Mexico.

Sayles Bleacheries, 250 horsepower, Saylersville, R. I.

It is obvious that much has already been accomplished in this important field of power generation.

3. No gas producer power plant can be successful unless the gas engine is adapted to suit the particular gas available for its use. On the authority of Westinghouse, Church, Kerr & Co., an engine which will develop 100 horsepower with natural gas will give only about 80 horsepower with producer gas —a loss of 20 per cent. With a 200-horsepower engine this loss would be about 15 per cent, and with sizes above 300 horsepower it would be about 10 per cent. Hence, the obvious necessity of designing the engine to suit for the particular fuel it is to use. Several failures have been made by neglecting this important point.

4. In the list of plants given above, it will be noticed that most of them are in remote regions where the cost of fuel is high, hence the high economy of the gas producer plant was necessarily a feature that commended itself.

5. The laxity of the laws regarding the smoke nuisance has not made it imperative for manufacturers to give attention to the prevention of smoke. As soon as regulations concerning the smoke nuisance are enforced the gas producer industry will receive a new impetus on account of the easy solution that the gas producer plant offers for this trouble.

Data relative to the design, operation and maintenance of gas producer plants, mostly highly favorable to the use of such plants, are given as follows:

1. A good gas producer, from the very nature of its construction and operation, does not allow the smoke to escape into the atmosphere; hence the gas producer itself presents a practical solution for the elimination of the smoke nuisance. The non-requirement of a chimney means a large saving in the first cost and in the maintenance of a power plant, and is an additional advantage in plants where the esthetic [illegible] the design are of importance; for instance, in the [illegible] municipal power plant.

2. The cost of labor required to operate a gas producer plant is about the same as that required in a steam plant of similar size. However, during the time that a gas producer plant is idle it requires less attention than does a steam boiler. In the case of a municipal pumping station, the labor required to operate the producer gas plant would be one half that of a similar steam plant, the gas plant being operated as follows: The gas producers to use coal for supplying the gas to operate a three-cylinder vertical gas engine direct connected to a triplex double acting power pump. In this case the usual fire engine will be dispensed with, and, should a fire occur the requisite pressure obtained by pumping directly into the system. For ordinary domestic supply the pump will deliver the water into a water tower, from which the mains receive the supply as needed. In every case the maximum quantity of water required during a fire is much larger than the average domestic consumption; hence the pump must be designed for this maximum quantity. As a result the working of the pump at its full capacity for six out of twenty-four hours would furnish enough water for the daily domestic consumption; the pump would usually be operated from 7 to 10 A. M. and from 3 to 6 P. M.

A gas holder of sufficient capacity to run the pump for thirty minutes is to be filled before the producers are closed down. Compressed air is to be used to start the engine, which may be put into motion simply by moving a lever. The engineer is to live adjacent to the plant so that when an alarm is sent in to the hose company and simultaneously to the engineer's home and to the plant it would be possible for the engineer to have the pump at work direct into the system by the time the fire company could reach the fire and make hose connections.

Since the gas holder would supply the engine until the producers could be started, the above scheme of operation eliminates the necessity of a night fireman and the keeping up of at least 70 pounds of steam pressure in a steam plant. A similar arrangement could be equally well adapted for fire purposes in connection with large industrial plants. With regard to the skill required, a producer gas power plant does not require any greater skilled labor than does a steam plant of similar size; however, in some cases it may require time for men trained to handle steam apparatus to become accustomed to gas engines and gas producers.

3. Two well-known engineering concerns give the following data regarding cost of installation:

The cost of gas power plants, including gas generating plant and gas engines, up to 500 horsepower, is about 25 per cent higher than the cost of a steam plant of similar size. Large plants, from 1,000 horsepower upward, cost about the same as a first class steam plant of similar size.

4. The cost of repairs on a gas producer plant will not exceed that of a boiler plant.

5. In order that a gas producer plant shall be commercially successful, it must be able to make, from a low priced fuel, gas that is sufficiently clean for use in an engine. Bituminous slack is usually the lowest priced fuel to be had, however anthracite culm, or even wood, may be cheaper in some localities. In all cases the percentage of sulphur must be low if the gas is to be used in a gas engine. Frequently the use of a mechanically washed coal will be economical.

6. The only reliable way to remove tar and other hydrocarbons from gas made from soft coal is to have the producer so arranged that the gas comes in close contact with an incandescent mass of carbon. No mechanical means has yet been found to be successful although several forms of centrifugal apparatus have been tried. For the removal of fine dust particles, however, centrifugal fans have proved very satisfactory.

7. The stand-by loss of heat is very small being limited to radiation only; a gas producer is tightly closed during the time it is not making gas and the entrance of air is thereby prevented. This feature is a marked advantage over a steam boiler under similar conditions.

8. Even after a producer has been idle for several hours

it may be started and can be working at its full capacity within fifteen minutes. A gas holder is generally used in connection with the producer, from which a supply of gas can be taken to start the gas engine instantly and keep it in operation until the gas producers are making gas.

9. A gas producer may be stopped instantly by simply shutting off the supply of air and steam.

10. The gas from the gas producer is quite uniform in composition, and as it usually passes first to a holder before reaching the gas engine, it becomes thoroughly diffused, thus insuring a still greater uniformity.

11. The thermal efficiency of gas producers is generally about 80 per cent and in some cases it is even higher than this value.

12. It is much easier to use an automatic feeding device on a gas producer than on a steam boiler, because all producers are placed vertically and the fuel can be dropped into position by gravity. The use of an automatic feed always decreases labor and insures more uniformity in the composition of the gas produced.

13. The rate of gasification in a gas producer is relative to the character of the coal used. The best rate determined by experience is 12 pounds of coal per square foot of grate area per hour, although some makers have advised as high as 20 pounds of coal. Experience has also demonstrated that too rapid driving opens a wide door for the admission of adverse gasifying conditions.

14. The amount and frequency of poking a gas producer will depend on the nature of the fuel and the design of the producer. The mechanical agitation of the fuel bed (as in the Kitson and Fraser and Talbot producers) eliminates poking entirely. In using bituminous coals the difficulties of clinker formations is augmented by the production of coke. The judicious use of a steam blast and automatic feeding will generally reduce poking to a minimum and, in some cases, will eliminate it entirely. Hand poking is very laborious for the attendant and usually it will be shirked whenever possible. Gas will usually escape around the poke holes while the producer is being poked, which will vitiate the air in the producer room and also affect the regularity of the composition of the gas.

15. The calorific value of producer gas varies from 125 to 150 B. T. U. per cubic foot.

16. The generation of 1 brake horsepower per hour with from 1 to 1.25 pounds of coal or 3 pounds of wood is very common producer gas power plant practice at the present time, and the gas contains at least 80 per cent of the heat energy resident in the fuel.

17. A very important advantage of the producer gas installation is that the gas does not condense or lose power on its way to the gas engine. On the contrary, the cooler the gas the better it is for the engine. With steam the condensation is considerable.

18. It is easy to prevent leakage of gas from the piping, owing to the low pressure of the gas (about 2 inches of water); whereas, with steam, there is often much loss and inconvenience on this account.

19. By using isolated engines a large saving in shafting may be made in many cases. It is not possible to do this in steam plants and still maintain a good economy.

20. The floor space required for gas holders, gas producers, and auxiliary apparatus is about the same as that required in a steam plant; the holder, however, need not be placed adjacent to the producers, but at any other convenient place.

21. A gas producer plant is under much better control than the average steam plant, because in the gas producers the air supply rate of gasification as well as the fuel supply can be regulated more easily.

22. One of the most potent advantages of the gas producer plant compared with the steam plant is the ability of the former to store the heat energy in a holder where it may be drawn upon for immediate use. In this way irregularities and fluctuations of load need not affect the regularity of the action of the gas producer. This condition means an economy of operation and convenience of use that are impossible with any steam plant.

23. Another important advantage of the gas producer power plant is that, in many cases, the gas may be used both for power and for metallurgical purposes, the same pipes being used to supply engines and furnaces. The plant of the Winchester Repeating Arms Co., at New Haven, Conn., illustrates an installation of this character.

24. In many cases it is a serious matter to secure a sufficient supply of water for a steam plant and sometimes, even with an adequate supply, the quality of the water is such that it is entirely unfit for use in a steam boiler. One of the most annoying difficulties of many steam plants is the trouble caused by the corrosion and subsequent cleansing of the boilers, together with the maintenance of feed water purifiers.

The gas producer power plant forms an almost ideal solution for the problem of water supply. With a producer in normal condition, the consumption of water will not exceed 2 pounds per brake horsepower hour. The water used in cooling the gases in the scrubber may be cooled in a simple tower and used repeatedly.

25. There is no difficulty in piping gas for several thousand feet in order to reach an engine that drives an isolated machine; this often makes it possible to dispense with abnormal lengths of line shafting and the consequent friction loss or other unsatisfactory methods of power transmission. This condition is especially valuable in places where electrical power is not used.

26. Standard gas producers now range from a few horsepower to more than 500 horsepower in size.

27. There is less danger of explosion in a gas producer plant than there is in connection with a steam plant; moreover, should an explosion occur it would be much less violent and destructive than that of a steam boiler.

28. If desired, the gas producer plant may be placed near the fuel supply, which in many cases would reduce the expense of transportation, the gas being piped to the gas engines of furnaces where it is to be used. This arrangement, which is impossible with a steam plant, means a decided saving in favor of the gas producer installation.

29. The preceding paragraphs show the many strong advantages of the gas producer as a power generator; the large number now in successful operation shows that the experimental stage has been passed and that they have become a formidable competitor of the steam boiler. The time is not far distant when gas producer locomotives for railroad service, gas producer portable engines and gas producer power plants for marine service will be in common use.

The advantages of the gas producer for each of the above three classes are:

I. Gas Producer Locomotives, being—

1. *Smokeless.*—*a*, Trains and stations may be kept cleaner; *b*, tunnels may be passed through with greater safety; *c*, comfort of passengers will be increased.

2. *Cinderless.*—*a*, Fuel loss will be decreased; *b*, comfort of passengers will be increased; *c*, large fire losses due to sparks will be eminated entirely; *d*, insurance rates on property adjacent to railroads will be less.

3. *More Economical.*—*a*, In fuel, since the amount used would be less than one-half that used on steam locomotives; *b*, in water, since the amount used would be less than one-eighth that used on steam locomotives; *c*, in time, since the time required to take fuel and water would be less; *d*, in labor in firing on account of automatic feed and decreased amount of fuel used; *e*, in idleness, since stand-by losses would be very low; *f*, in number of fuel and water stations required.

4. *Safer*, since the danger of boiler explosions is eliminated.

II. Gas Producer Portable Engines, being—

1. *Smokeless.*—*a*, Large fire losses due to sparks will be eliminated entirely; *b*, insurance rates on property adjacent to where an engine is used would be less.

2. *More Economical* in, *a*, water; *b*, fuel; *c*, labor; *d*, time required to secure fuel and water.

3. *Safer*, the danger of explosion being eliminated.

III. Gas Producer Power Plants for Marine Service, being—

1. *Smokeless.*—*a*, Ships may be kept cleaner; *b*, passengers will have more comfort; *c*, a battleship could conceal its location more easily.

2. *More Economical* in, *a*, fuel; *b*, water; *c*, time required to fuel; *d*, bunker capacity; *e*, floor space; *f*, apparatus required, since all of the condensing machinery would be dispensed with.

CRANE MOTOR TESTING APPARATUS.

One of the interesting features of the big new Pawling & Harnischfeger plant on National Ave., Milwaukee, Wis., is the motor-testing apparatus in the crane motor department. Practically all the crane motors used in their crane installations are made in a well-equipped department for the work, at the east end of the shop. The motor-testing plant is at one end of the department, where a special switchboard and necessary apparatus have been installed for the testing work. Two testing machines are provided of different capacities in order to conveniently handle both large and small motors. Crane motors, being of the series-wound type, are tested for variable loads at variable speeds, the tests being conducted from no load to 50 per cent overload. The apparatus consists of a generator mounted on trunnion bea[illegible] a cast-iron platen so that the generator frame can [illegible] through a limited arc on an axis corresponding with the shaft axis. The motor to be tested is mounted on the platen in line with the generator shaft and is coupled to it by means of a flexible coupling, Fig. 3, which takes care of slight variations of alignment [illegible] ator shaft, a [illegible] point at a fixed [illegible] from the platen wh[illegible] center in the motor shaft when in the correct position. A tongue in the bottom of its base fits in the groove on the light projecting part of the platen seen in front, Fig. 2, and this

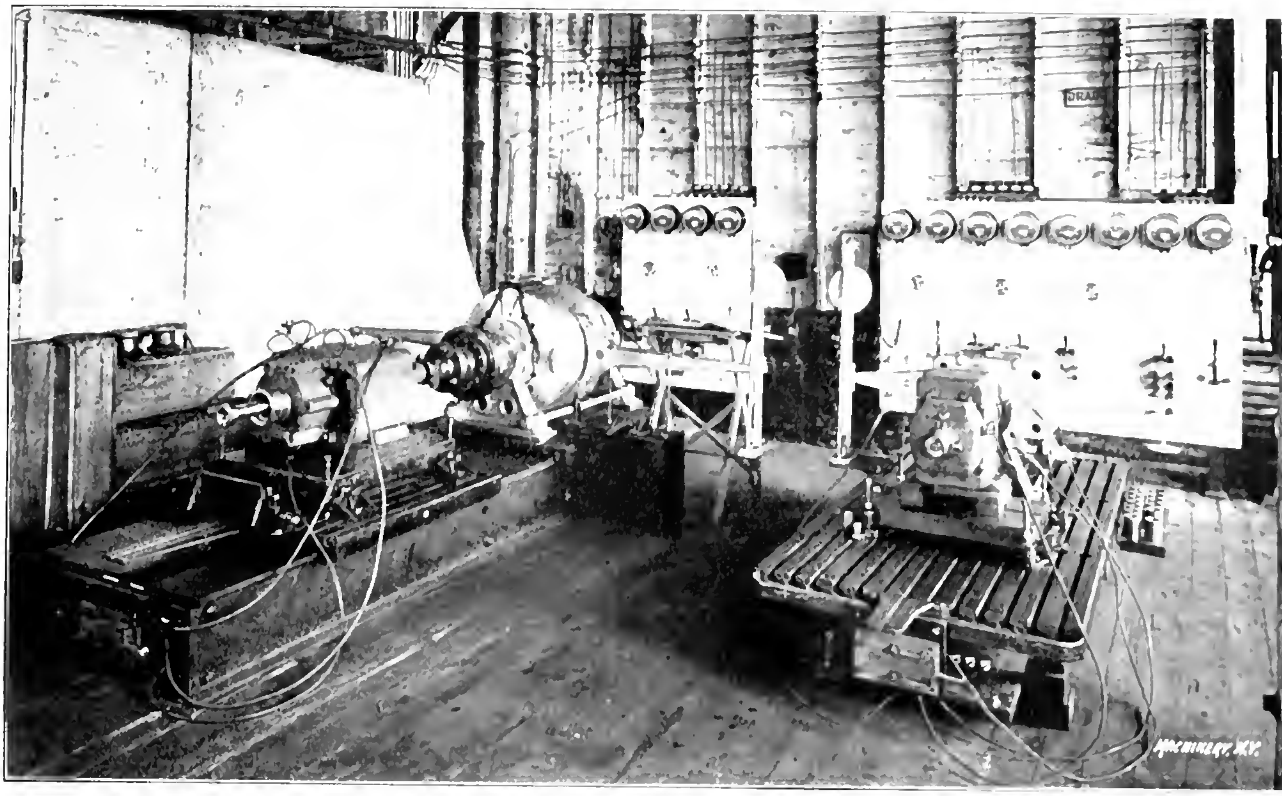


Fig. 1. View of Crane Motor Testing Apparatus, Pawling & Harnischfeger Shop, showing Switchboard

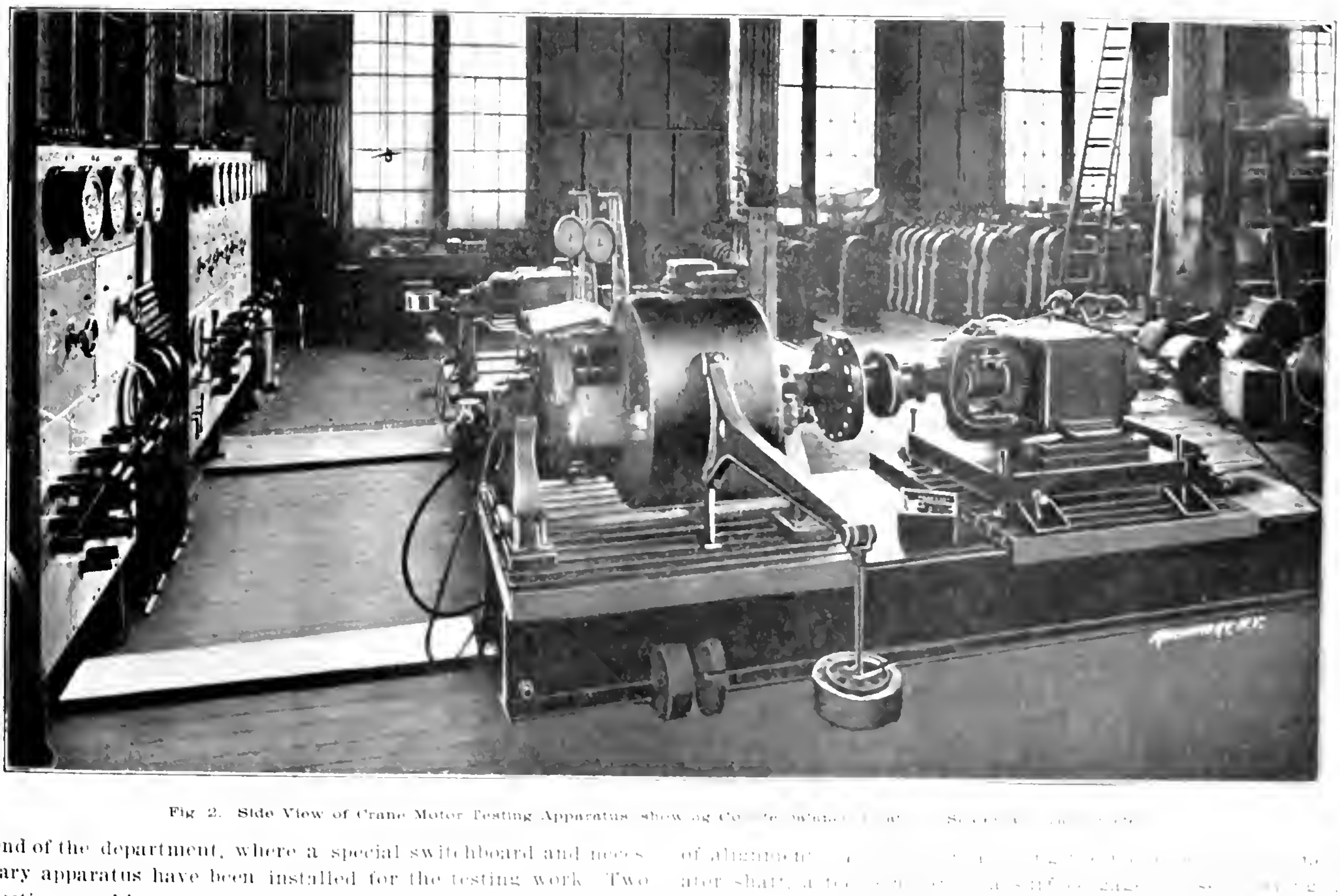


Fig. 2. Side View of Crane Motor Testing Apparatus, showing Co[illegible]

provides a convenient and simple means of securing close alignment. The testing generator has two arms attached to the frame on opposite sides, to one of which is fastened a Chatillon weighing scale and to the other a counterbalance. The scale arm is made a specified length of 63⅛ inches from the center of the generator. With this length of scale arm a factor of 1/1,000 makes the H. P. formula for prony brake read $\frac{\text{R. P. M.} \times \text{pounds pull}}{1{,}000}$ = brake H. P. A Schaeffer & Budenberg tachometer or speed indicator is attached to the end of the generator armature shaft, thus giving direct read-

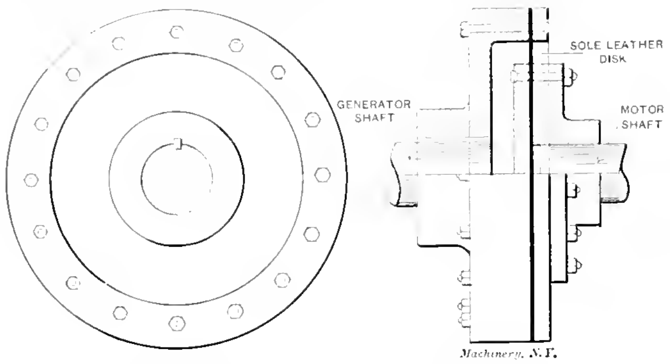


Fig. 3. Flexible Coupling between Motor and Generator.

ings of the speed at any moment. Hence, by observing the pull in pounds on the scale and the number of revolutions per minute, the brake horsepower may be instantly computed. For instance, if the revolutions per minute are 700 and the pull is 5 pounds, the brake horsepower is 3½ H. P.

The wiring for the testing services is of the parallel system. The motor to be tested is mounted on the platen and connected to the generator, and is operated at its normal speed. The field current of the testing generator is then regulated until the voltage in the latter is the same as the voltage supplied to the motor and then the two are switched together by starting box No. 2. The current for starting the motor and exciting the testing generator is supplied by the generator in the power house, the regulation of voltage being controlled from the testing department switch as shown by rheostat No. 3. The variation of motor load is obtained by regulation of the testing generator current through the rheostats Nos. 1 and 2, the latter also being arranged for series or parallel connection by small switches. From this it will be apparent to those familiar with electrical operation that the motor under test is driving the generator and, in effect, returning to the line the equivalent of the current consumed, minus the friction loss in the bearings, and the current loss in the two machines.

The apparatus is also adaptable for making reversed rotation tests of motors, it being essential, of course, that a crane motor should be reversible. The apparatus is also adapted to controller tests which are made by wiring the controller to a large capacity motor the armature of which is held by a specially designed brake, the brake being controlled during the test for any desired amperage. As each set of resistance is cut out on the controller, the volts and amperes are noted as shown by the instruments on the switchboard, and these readings are tabulated in a card index. In this connection it might be noted that all records of motor and crane tests are carefully kept in a very complete system of records. For the sketch, Fig. 4, illustrating the wiring of the apparatus, and the technical description of this apparatus, we are indebted to Mr. F. P. Breck, of the company's testing department.

* * *

TECHNICAL PUBLICITY ASSOCIATION.

An association has been formed of the various technical publicity departments of large manufacturing firms, especially those in the machinery field. Many manufacturers now have regularly organized departments devoted exclusively to disseminating information in regard to their products. Circular matter is prepared in these departments, data are supplied to the technical press, and advertising matter is made ready for the different journals. In these and other ways the publicity department keeps those interested informed upon the work of its firm, with results that are beneficial all along the line. Not only can more systematic work be accomplished, but these departments have able and technically trained men who prepare matter for distribution that rises above the grade of commercialism and becomes of real value to the technical reader, or to those in search of exact information in regard to different products.

There are now so many persons engaged in this important work that it has become possible to organize an association for their mutual good, and the first meeting was held in New York on April 27th, when an address was made by Mr. Emerson P. Harris, a well-known broker in publishing property upon "Machinery for Marketing Machinery."

Mr. Harris, whose familiarity with different publications is unusual, said that in no other department of publishing had the advertising medium risen to so high a degree of efficiency as in the technical field. The keynote of the ideal technical or trade paper is helpfulness to its readers. The greatest helpfulness depends upon a knowledge of the wants of a reader and sympathy with him on the part of the editor on the one hand, and on the readers by the confidence in the accuracy, reliability and truthfulness of the contents of the paper.

When these conditions between the editor and the readers are established, the technical journal undoubtedly becomes the

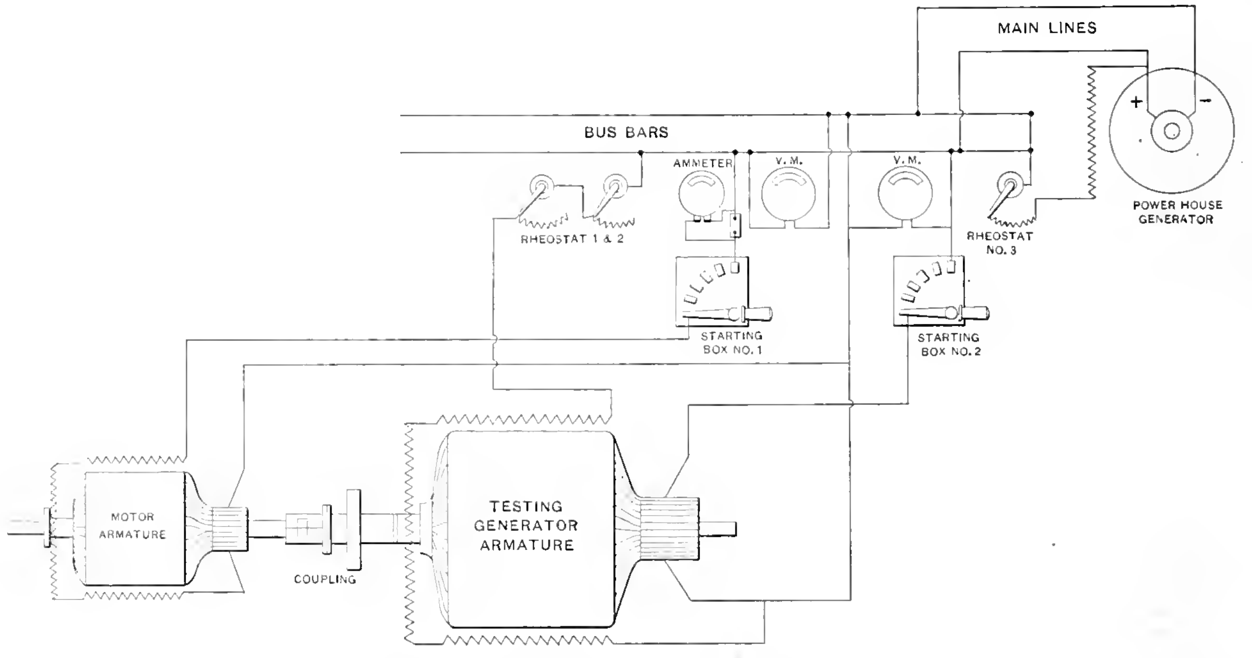


Fig. 4. Wiring Diagram of Pawling & Harnischfeger Crane Motor Testing Apparatus.

most effective advertising medium to the marketer of machinery. The mood which the editor inspires is carried over by the reader to the advertising page, and if it is one of confidence, and of interest in the new and important developments in the field of the publication, the advertisements are then looked upon with interest and in confidence. It is these psychological facts which make the best technical journals so efficient an advertising medium.

A question to be decided by the advertiser is whether a publication actually reaches the class of readers desired. No matters how good a paper is, it will not sell itself any more than machinery will. Circulation costs money. It requires much more in the case of technical papers than the circulation receipts begin to furnish the incentive for spending. It costs little to get a few subscribers in any field and to do business on these and a few sample copies—and "wind." Papers run on this plan can grant all kinds of accommodations in the way of puffs, for they have no faith to keep, nor character to lose. Such papers can make low rates but the space is likely to be had at any price.

The advertiser should know not only how many people pay for and read the paper, but he should have, as far as possible, an analysis of the circulation showing the classes of people who read the paper. This association would have an immense influence for good if it would not only insist upon having proof of circulation but, also, upon knowing how the circulation is obtained.

The speaker further commended the tendency toward concentrating advertising in fewer and stronger papers and using those papers intensely. Intensive is better than expensive advertising.

There were present at this meeting of the association the following members: Philip P. Kobbe, Rand Drill Co., President; H. M. Cleaver, Niles-Bement-Pond Co., Vice President; C. B. Morse, Ingersoll-Sergeant Drill Co., second Vice President; Geo. H. Gibson, International Steam Pump Co., Secretary; H. M. Davis, Sprague Electric Co., Treasurer; Rodman Gilder, Crocker-Wheeler Co., and Graham Smith, Westinghouse Companies, Executive Committee; H. T. Lauretzen, Holophane Glass Co.; F. S. Wayne, Robins Conveying Belt Co.; Lucius I. Wightman and Fred C. Iglehart, Ingersoll-Sergeant Drill Co.; M. C. McQuiston and J. O. Little, Westinghouse Companies; C. P. Hutchins, Jos. Dixon Crucible Co.; F. C. Cheston, American Wood Working Machinery Co.; Dean Park, Hammacher, Schlemmer & Co.; F. R. Matthews, De La Vergne Machine Co.; Dixon Boardman, Hall Signal Co.; H. F. Gale, General Electric Co.; C. S. Redfield and R. R. Glenn, Yale & Towne Mfg. Co.; A. E. Michel, International Steam Pump Co.; A. N. Barker, John A. Roebling's Sons Co.; W. B. Snow, B. F. Sturtevant Co.; E. F. Schaefer, Rand Drill Co.; H. H. Kress, Cameron Steam Pump Works; F. B. Vail, American Air Compressor Works; Arthur Warren, Allis-Chalmers Co.; A. L. Newton, I. T. E. Co.

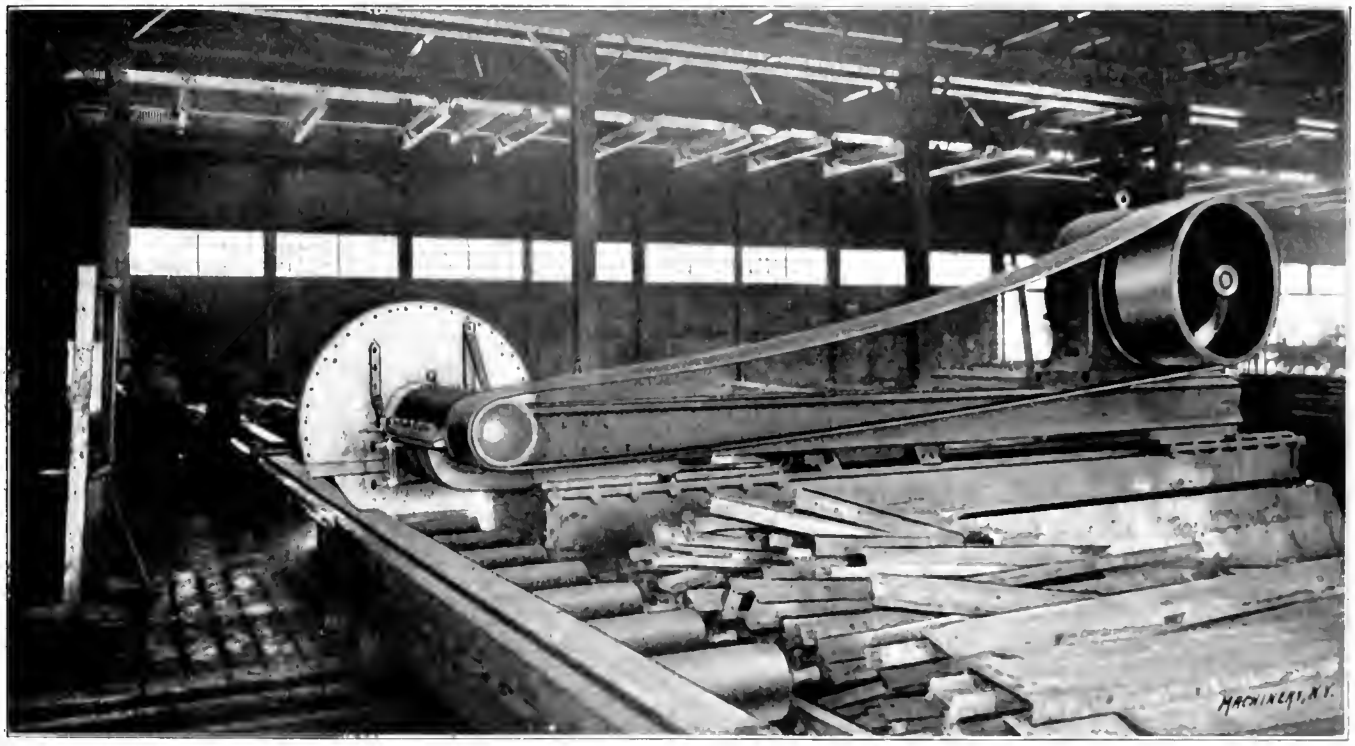
* * *

A LARGE FRICTION SAW.

The cutting of structural steel by friction saws has been done in the larger steel mills for several years, the rapidity of the cutting and adaptability for quick handling of material making this method superior to shearing or "cold sawing." The latest thing in this line of machines is a saw recently installed at the new 16th Street plant of Joseph T. Ryerson & Son, Chicago. This saw was designed by their own engineer, Mr. H. A. Ferguson, and was built by H. W. Caldwell & Sons Company, Chicago. It is of the type having a stationary bed of rollers, the saw moving across the work at a right angle.

The machine itself consists of four 12-inch 40-pound channels, 22 feet long, laid parallel and firmly secured by tie plates to the foundation. On top of these channels at each end are heavy castings with V-shape grooves and oilers. In these grooves slide the upper frame, also composed of four 12-inch channels, and having the shaft bearing on the front end, and the motor mounted on the rear. The shaft bearing is of the ring-oiling type, especially designed to take care of the high speed of the shaft and has an oil well capacity of fifteen gallons, dust proof. The motor is alternating current 100 horse power—220 volts at 580 R. P. M. It carries a drive pulley 48 inches diameter and a 16-inch three-ply belt. The pulley on the saw shaft is 14 inches diameter, giving a speed of 1,988 R. P. M. The saw disk is made of soft flange steel, 5/8-inch thick and 52 inches diameter, giving it a peripheral or cutting speed of something over 27,000 feet per minute. The upper part of the saw is covered with a shield of sheet steel, which prevents the abraded material being thrown above and back of the saw, and the operator, who stands in front, is protected from the flying sparks by a glass frame. An 8-inch hydraulic cylinder secured to the bed frame moves the upper frame back and forth across the work. The rollers for moving the material to be cut are 10 inches in diameter and power driven in two sections, one for bringing along material to be cut, and the other for taking it away.

The rapidity with which this machine cuts steel is simply marvelous. It goes through a 15-inch 42-pound I-beam in 9 seconds; a 20-inch 65-pound beam in 12 seconds; and a



Large Friction Saw in Joseph T. Ryerson & Son's Plant, Chicago, for Cutting off Structural Shapes

24-inch 100-pound beam, or the largest size rolled, in 16 seconds. Its operation is accompanied with an ear-piercing shriek that is almost deafening, but the result is that the speeds of cutting off are far ahead of any previous records on cold steel.

* * *

ELECTRIC MOTORS IN STEEL MILLS.

The use of electric motors in steel mills was begun early in 1893, when two electric traveling cranes were installed, one in the Edgar Thomson Steel Works, Braddock, Pa., the other in Homestead Steel Works at Munhall, Pa., both of these plants being operated at the time by the Carnegie Steel Company. At that time, all machinery in mills was steam driven. The use of motors has proven so successful that to-day practically all auxiliary machinery is motor driven and mill engineers are now beginning to seriously consider the driving of the mills themselves by electric power. Only a short time ago an order was placed for two 1,500 H. P. 220-volt motors, which will be used for driving a rail mill at the Edgar Thomson Works of the Carnegie Steel Company. The use of motors, as large as these, may seem a radical step to many, but it is thought that, by introducing a flexible element between the prime mover and the load, which is of an excessively intermittent character, that there will be a sufficient saving in repairs to pay for the additional equipment within a few years. The maintenance on steam engines used for driving mills is, probably without exception, higher than in any other class of service.

In the application of electric power in steel mills, by far the most difficult problem presented, has been that of driving the main mill tables with motors. Many plants can be found where the "transfer," "run out," "shear" tables, etc., are all motor driven, but the main mill tables still steam engine driven. There are several reasons for this. To begin with, these rolls must be reversed at very frequent intervals, in many cases ten times per minute. The average operator cannot be depended upon to use any judgment whatever in the handling of the controller. This means that the motor is liable to receive enormous rushes of current, which are not only destructive to the motor itself, but the resultant jerks to the machinery in general are sufficient, in some cases, to twist off shafts, strip gears and do much other damage of a like character. Even if the operator were careful, when the motor is suddenly reversed, its counter electromotive force causes it to act as a booster in series with the generator and thus, at the moment of reversal, there is almost double the line potential across the starting resistance and the motor consequently receives almost double the first rush of current which it should receive. This may seem to be merely a question of the proper design of the starting resistance, but if we stop to consider what it means to double the resistance in the ordinary manually operated controller, it will at once be seen that such a scheme is unfeasible, due to the increased drop across the various steps of resistance and the consequent sparking on the contacts.

To sum up the situation, it will be see that, in order to secure satisfactory results from motors used on this class of service, that the flow of current to the motor must, at all times, be automatically limited to a pre-determined maximum value. It is at once apparent that the operator cannot be depended upon to secure this result by the proper handling of the controller, and so there is but one expedient remaining to consider, a controller which will accomplish this result automatically. In other words, a controller, which might be termed an intelligent self-starting device.

The Cutler-Hammer Manufacturing Company have just installed in the new rail mill at the plant of the Republic Iron & Steel Company, Youngstown, Ohio, a number of controllers, which seem to fulfill the requirements for this class of service. These controllers are installed in connection with motors driving tilting tables, catcher's tables, etc. They consist of a drum type reversing switch and a number of solenoid controlled switches for cutting out the starting resistance. The drum type reversing switch, which is used to handle the main current of the motor, is equipped with powerful blow-out magnets. The accelerating switches are mounted on a slate panel carried on a switchboard frame. The operation of these controllers is as follows:

The operator closes the circuit to the motor on the drum type reversing switch for either one direction of rotation or the other and the motor is thrown across the line in series with all of the starting resistance. At the same time, the circuit of the solenoid switch, controlling the first section of accelerating resistance is closed. This switch in closing cuts out a section of the starting resistance and at the same time closes the circuit of the switch controlling the next section of starting resistance and so on through the entire progression of switches. In conjunction with these accelerating switches is a series relay solenoid, which may be adjusted to pick up on any predetermined current. This relay is so connected with the accelerating switches that, when it lifts, no more accelerating switches can close. Those switches that are already closed, however, are maintained in that position. In other words, the process of acceleration is halted until the current has fallen below the predetermined value. By using solenoid switches for cutting out resistance, all sparking is eliminated and sufficient resistance may be provided to hold down the motor current even when it is suddenly reversed and its consequent booster action produced.

On a test made on a 75 H. P. motor driving a tilting table, the motor was brought from full speed forward to full speed reverse in three seconds without the motor current at any time, exceeding 125 per cent of full load current. With such a controller in use, the use of motors on mill tables appears perfectly practicable, and no doubt, the next few years will see the steam auxiliary engine driven from its last stronghold in the steel mill. Perhaps, the next ten years will see the use of the steam engine for direct driving entirely dispensed with. The results of the above mentioned installation at the Edgar-Thomson Steel Works will, no doubt, be the deciding factor in this regard.

In connection with the foregoing it is of interest to note that the Cutler-Hammer Company has just received an order covering two 1,500 H. P. 250-volt automatic release starters for use in the Edgar Thomson Steel Works. These starters are particularly interesting, not only on account of the size, but on account of the general arrangement of the starter, the unique type of resistance used, and the large overload capacity of the equipment.

The starter proper will be built in the form of a switchboard of white Italian marble, approximately 7 feet 8 inches high and 11 feet long. The starter parts will be of the well-known type made by the company where the several sections of starting resistance are controlled by a number of independent levers. For the starter in question, the levers which will carry the motor current continuously are to have a continuous capacity of 10,000 amperes, and are guaranteed to carry this amount with a temperature rise not exceeding 40 deg. C. The intermediate starting levers, which as occasion demands, may also be used temporarily for regulating duty, will have 6,000 amperes capacity on the same basis.

The switchboard will consist of five panels, each panel containing two levers. The connection between the different panels will be made at the rear of the switchboard by bus-bars in the usual manner. At the front of the switchboard, such arrangements will be made that with very little trouble an entire panel may be removed from the board without disturbing the other panels, or the parts mounted on them. It will even be possible to operate the starter with one of the intermediate panels removed. The levers on the several panels are mechanically interlocked in the manner adopted for the multiple switch type of starters, so that the several levers composing the starter cannot be operated except in a predetermined order. As giving some idea of the large size of the starter levers, the overall length of each of the levers is a trifle over 3 feet, but by means of a toggle joint action these heavy switches may be closed with a remarkably small amount of force.

The resistance for these starters will consist of standard steel rails, mounted in a steel rack, approximately 20 feet high, 14 feet wide and 27 feet long. There will be about one hundred 25-pound rails and two hundred 40-pound rails used. This enormous capacity of resistance material is provided so

that the resistance may be used to control the speed of the motor for short periods of time, even under comparatively heavy loads without permanent injury. The main connections to the starter will consist of six 1,000,000 circular mill cables, while the intermediate resistance leads will consist of four 1,000,000 circular mill cables.

The motors which these starters will be used to control are of the Westinghouse make, and will be very heavily compounded. The motor armature shaft will carry a flywheel 20 feet in diameter, weighing approximately 125,000 pounds, and will be directly connected to the standard blooming mill rolls. The motors will be designed to stand very heavy overloads for short periods of time, and mechanically constructed so as to stand the enormous strains encountered in this service. The normal speed of the motor will be 100 R.P.M., and allowances will be made so that this speed may be increased 25 per cent by weakening the shunt field of the motor. If the installation of these motors proves satisfactory, which result is confidently expected, the Carnegie Steel Co. will equip the mills in its other plants with motors instead of the cumbersome steam engine now used.

For some time, the Pittsburg Reduction Co. has had a 1,500 H. P. 500-volt motor driving a blooming mill in satisfactory operation at its plant at Messina, N. Y., which is controlled by a 500-volt starter, similar in construction to those to be installed at Braddock. Since installation, this particular equipment has given every satisfaction, and it would now seem as if the motor drive was considered perfectly feasible for the largest mills.

* * *

ERRATUM.

A correspondent, Mr. R. S. Wright, of Sherbrooke, Quebec, Canada, calls our attention to an error in the article on Steam Hoisting Machinery by Mr. A. M. Levin in the May number of MACHINERY. The formula on page 455 of that issue for the normal pressure exerted by each beam of a post brake should read $N = \frac{n\,l}{m\,a}W$ instead of $\frac{1}{2}\,\frac{n\,l}{m\,a}W$ as it appears in Mr. Levin's article. This is evident from the following consideration, referring to figure No. 3: the weight W produces a turning moment about the fulcrum equal to Wn, $\frac{1}{2}$ of which is taken by each of the vertical rods. Hence the pull in each rod is $\frac{1}{2}\,Wn \div m$. This in turn produces a turning moment about the fulcrum at the top and bottom respectively of the brake beam equal to $\frac{1}{2}\,W\frac{n\,l}{m\,a}$, bringing a pull on each of the horizontal rods equal to $\frac{1}{2}W\frac{n\,l}{m}$. Hence the total normal pressure of each beam against the face of the brake is the sum of the pulls of these two horizontal rods, or $N = \frac{n\,l}{m\,a}W$.

Formula fourteen thus should read $L\,R < 2\,f\,r\,\frac{n\,l}{m\,a}\,W$ and (15) becomes $W > \frac{L\,R\,a\,m}{2\,f\,r\,n\,l}$.

* * *

THE "CORE AND COIL" PROBLEM.

In an address, "Unsolved Problems in Electrical Engineering," delivered by Col. R. E. B. Compton at the April 10, 1905, meeting of the Institution of Civil Engineers, attention was called to the "core and coil" problem, and the defects of the present system of winding coils. "Winding is done in three ways: "First with round wire wound with the wires of one layer substantially over the wires of the layer beneath. The second is also a usual form, and allows of a more solidly wound coil—that is, when the ends of the winding are stepped back, the succeeding layers fitting in some extent, between the depressions of the previous layer. But the third case constitutes an ideal winding of a coil to produce the same strength of magnetic field, and to give sufficient cooling surface to get rid of the heat, but using less copper, and having greater heat conductivity on account of the continuity of the copper from the inside to the outside of the coi[illegible] winding consists of thin copper strip wound on its [illegible] correct position by suitable machinery, each turn being insulated from the adjacent turn by a thin film of insulating material applied to it at the time it is being wound. This ideal form of coil winding has already been occasionally used in practice for the larger coils required for certain transformers, and for the magnets of large generators and motors; and it will be seen that we gain greatly in reducing the bulk of the winding, weight and cost of copper; and as the magnet arms are shorter, we gain greatly in the size and cost of the frame work of the machine; but in order to apply it generally to the smaller class of apparatus we still require a combination of rolling, winding, and insulating machinery which will take the rough copper strip and at one operation reduce it to the correct cross section, wind it into place, and apply the coating of insulating material. The limit of temperature which insulation should continuously stand should be increased to at least 390 degrees F., and if we are successful in obtaining the two requirements which I have mentioned, viz., the reduction in the sizes of our coils, by means of the last form of winding I mentioned, and the utilization of the higher temperatures at which we can work them without endangering the durability of our plant, we shall benefit greatly, both constructors and users, by reducing the bulk, weight and cost of our machinery, without in any way impairing its efficiency."

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JUNE MEETING OF THE A. S. M. E.

The semi-annual meeting of the American Society of Mechanical Engineers to be held at Scranton, Pa., takes place from June 6 to 9 inclusive. The subjects of the papers to be presented are as follows: "The Transfer of Heat at High Temperatures" by Frank C. Wagner; "Standard Unit of Refrigeration," by F. E. Matthews; "Formation of Anchor Ice and Precise Temperature Measurements," by Howard T. Barnes; "Some Types of Centrifugal Pumps," by Wm. O. Webber; "Microstructure and Frictional Characteristics in Bearing Metals," by Melvin Price; "Cast Iron, Crushing Loads and Microstructure," by Wm. J. Keep; "Smoke and Its Abatement," by Chas. A. Benjamin; "Can a Steam Turbine be Started in an Emergency Quicker than a Reciprocating Engine of the Same Power?" by A. S. Mann; "Notes on Efficiency of Steam Generating Apparatus," by A. Bement; "Performance of a Superheater," by A. Bement; "Counterweights for Large Engines," by D. S. Jacobs; "Steam Actuated Valve Gear," by Wm. H. Collier; "Notes on Heads of Machine Screws," by H. G. Reist; "Belt Creep," by W. W. Bird; "Function of Laboratory Courses in the Curriculum of Engineering Schools," by Chas. E. Lucke; "Continuous Measuring and Mixing Machines," by E. N. Trump; "Epochs in Marine Engineering," by Geo. W. Melville.

* * *

Something over two years ago it was discovered in the cement testing laboratory of the C. M. & St. P. Ry. that a Portland cement briquette two years old was disintegrated by drippings of signal oil. The importance of the discovery caused a series of tests to be made to find out what the effect of oil was on Portland cement generally, and what could be done to prevent deterioration of cement structures which were unavoidably exposed to oil drippings. A report of these tests is given in the *Engineering Record*, but the investigation is of a negative character so far as finding any preventive. Painting with linseed oil paint delayed the action somewhat, but it eventually succumbed. Paraffine and sodium stearate were used with no better results, as was also the case with Sylvester's process for making cement impervious to water, which consists of alternate washes of 5 per cent. solution of alum and 7 per cent. solution of castile soap. In view of the fact that concrete construction is being largely used for roundhouses, oilhouses and other structures exposed to oil drippings, it seems highly necessary to find some means for correcting this fault. It is altogether probable, however, that mere oil spattering would not seriously deteriorate a concrete floor for a long period as the oil would probably be more or less oxidized before penetrating to any great depth.

LETTERS UPON PRACTICAL SUBJECTS.

GAGE MAKING.

Editor MACHINERY:

Possibly there is no branch of the tool-making trade that demands the skill and accuracy that gage making does. For one reason or another we seldom see anything in print regarding this exacting line of work; one reason is that a gage maker might enter very carefully into detail as to the manner in which to make this or that gage, but said detailed description would not apply to the method employed in the next shop. The object of this article is to touch briefly upon different methods and gages.

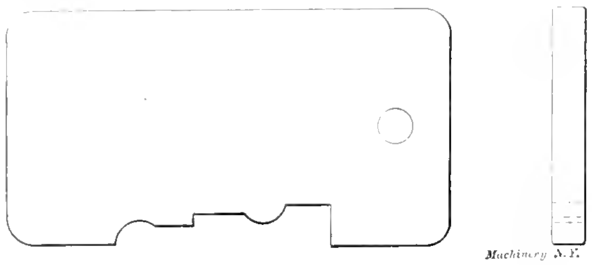


Fig. 1. Profile Gage.

It is becoming the general practice to make gages from machinery steel and caseharden same. As a small fraction of 0.001 inch renders a gage useless as a standard, it is therefore obvious that machinery steel hardened to a depth of 0.003 to 0.005 inch answers fully as well for gages as tool steel. But to obtain best results from plug and ring gages they should never be made of machinery steel. First, the gage may spring slightly during the hardening process, and as the gage is only hardened to a depth of 0.003 inch or thereabouts, the reader can readily see that the casehardening can easily be lapped away, leaving soft spots in the gage; this not only shortens the life of the gage but said soft spots "charge" with emery when lapping the gage to size, making the finished product half gage and half lap. But for snap gages and profile and receiving gages machinery steel is superior to tool steel, due to the fact that the gage is not distorted to any extent during the hardening process. The writer has found by experience that best results are obtained, when making plug gages, by using stock somewhat larger than finish gage size. For instance if the plug gage is to be 1 inch diameter, make same from a bar of steel say 1⅛ inch or larger. By so doing the scale and outer stock that has apparently been decarbonized to a certain degree is entirely removed. This same point is applicable to reamers, mandrels, dies and numerous other jobs that require hardening. To go further, let us suppose that a plug gage 1 inch diameter is turned up from a bar of steel slightly larger than 1 inch. After hardening it will be noticed that there are spots that seem to bulge; said spots are hard, but the surrounding stock is apparently soft. But, if the gage is ground to say 15-16 inch diameter, it will be found hard over its entire surface.

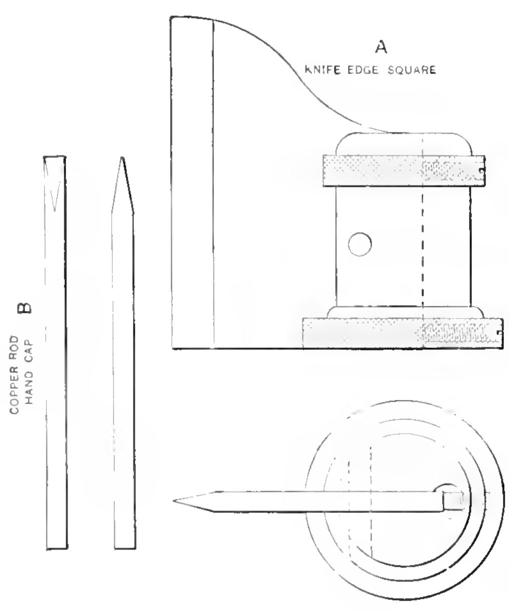


Fig. 2. Fig. 3.

The methods of making gages vary greatly in different shops, *i. e.*, some manufacturers are content with gages turned and filed nearly to size, which after being hardened are polished to size with emery cloth. In the next shop we find the

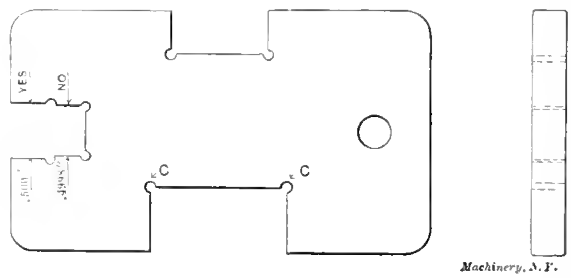


Fig. 4. Common Snap Gage with Clearance for Lap.

gages are hardened and ground to size. The next shop is more exacting and the gages are ground and lapped. Going still further we find manufacturers who are still more exacting, and demand that gages must be hardened, roughly ground, aged, finish ground, lapped, and the minute ridges caused by circular lapping, entirely removed by lapping the gage lengthwise to size. About 0.0001 inch is removed by this operation. The laps and manner in which steel is aged was described in the May, 1904, issue of MACHINERY.

When making a profile gage, Fig. 1, it is a good plan to first make a sheet steel templet to fit model perfectly. A planer tool is now fitted to the templet and the impression planed through three gages at the same setting. (The three gages referred to are master, inspector, and working gages.) Should the profile be of such a size as to render it impracticable to plane the entire surface at once, a series of formed tools are

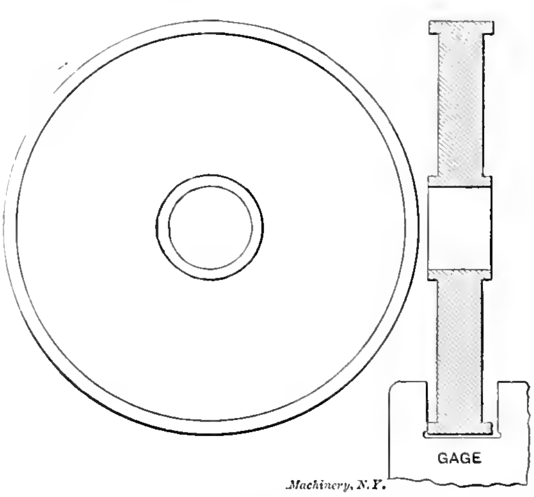


Fig. 5. Cast Iron Lap adapted to Lapping between Jaws.

then made, also a male templet, and the impression is planed to fit said templet reasonably close and then finished by hand. As it is absolutely necessary that the profile be the same over its entire surface, the knife-edge square, Fig. 3, will be found exceptionally well adapted for this work. The gages, after hardening, are lapped by hand to fit model by means of a flattened copper rod, Fig. 2, and flour emery. Should the gage "open a trifle" during the hardening process, the vise will prove an admirable "putting on tool," as the interior of gage is soft.

The common snap gage, Fig. 4, is carefully machined to within 0.002 inch of finish size, care being exercised that the

faces are smooth. The holes $C\,C$ are made to allow clearance for lap, Fig. 5, which is a cast iron disk. The gage is nicely casehardened, and gripped in the vise of an old milling machine, preferably a hand machine reserved for this operation. The lap is placed on the arbor, smeared with emery paste and set in motion. By moving the table back and forth the gage can be lapped until the model can just be started to enter. The gage should then be finished by hand. If the gage is made to dimensions instead of a model, it is a good plan to make a temporary gage of drill rod, and fit the gage to same.

Fig. 6 shows a very simple style of snap gage, one that is easily duplicated. This gage requires the spacers E, which are made the required size, that is, the size of the piece to be

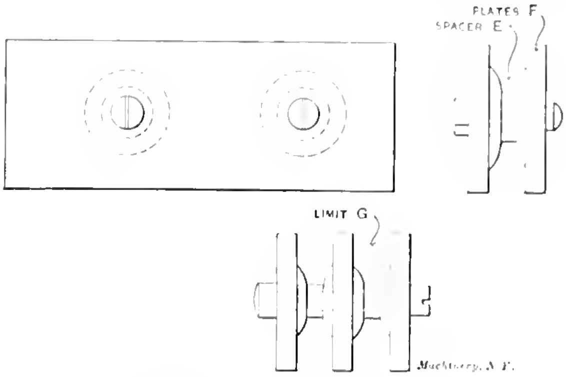


Fig. 6. Easily Duplicated Snap Gage.

gaged. The plates F are parallel pieces of hardened steel that have been ground and lapped. When the gage becomes worn, all that is necessary to duplicate the original size is to remove the plates and lap the surface true. A limit gage can be made by adding another plate and spacers of proper length, as at G.

The receiving gage, Fig. 7, is a very difficult gage to make and on account of the cost it is rarely used except where it is absolutely necessary to do so. The gage is made to fit perfectly the entire profile of the piece to be gaged, and is made of a series of small pieces fitted together, the object being to overcome as far as possible the distortion of steel when passing through the hardening process. The base H is of machinery steel casehardened, and its upper surface lapped perfectly level. The pieces J are ground and lapped on bottom, and the formed edges are lapped by hand to fit model. To obtain best results fit the pieces J to model while pieces are soft and fasten pieces to the base H by screws. The dowel holes are now drilled and tapped with a fine pitch tap, say 5-16 x 32. After pieces J and base are hardened, soft steel screws are

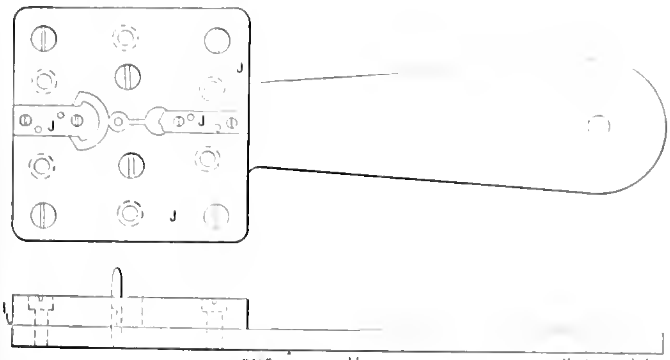


Fig. 7. Receiving Gage for Pallets

turned securely into these holes and dressed off flush with top and bottom of pieces J and base. After the pieces are lapped to fit the model, they are tightened in their places, and the soft screw bushing drilled and reamed through for dowels. It is impracticable to attempt to lap dowel holes true, especially when they are tapered and do not line up. This soft screw bushing will be found useful on many other tools where dowel holes are apt to change during hardening.

Fig. 8 shows a universal snap gage that is designed especially for large work. All that is necessary to make one gage cover the field is to set the gage to required diameter (from standard length rods, so that pointer stands at zero) then as the gage hangs on the piece to be gaged, it is swung so that anvil L passes over highest point, and the pointer will record 200 times greater than what the error really is. Any one who has used a large micrometer for measuring such work as is found in arsenals knows the diagreeable manner in which one is obliged to obtain measurements. One man will

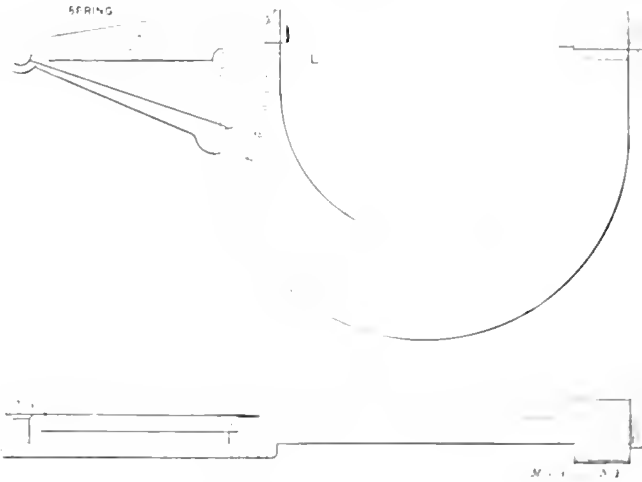


Fig. 8. Universal Snap Gage for Large Work

hold the micrometer on the breech of a large gun and another man will do the measuring. With this form of gage one man can measure very handily, as all that is necessary to do is to note the number of graduations traversed by pointer when gage passes over work. F. E. Shaylor.

Great Barrington, Mass.

AN ADVERTISING SCHEME.

Editor Machinery:

One of the problems of modern business is advertising—to bring goods to the notice of people likely to need them and to do it in such a way as to impress possible customers and cause them to remember that John Smith makes the Eureka hash grinder, and that it is the only hash grinder worth having, etc. To obtain this end a great variety of methods are in use, from obscene literature and vulgar devices, to works of art and things of great usefulness; in fact almost every one adds materially to his education by reading advertisements. It must be a source of pleasure to a good man to feel that his advertisements are not only increasing his business, but are an actual benefit to humanity and to such men I wish to suggest the following plan:

Wherever there is machinery there is always danger of some one getting injured, and in case of an accident few people understand how best to treat the sufferer, and again, very few factories have at hand any drugs, bandages, etc., so necessary in such cases. So quite often the unfortunate one has to suffer more than is necessary before medical assistance can be obtained, and not the least of his sufferings is the feeling of helplessness and uncertainty produced by the inability of those about him to help him.

Now my plan is for some one who has an article he wishes to advertise in manufacturing establishments, to furnish a small outfit of drugs, bandages, etc., selected for the purpose, and with each outfit several large placards, with the request that these cards be placed in prominent places about the factory where every one can read them. These cards could carry the advertisement of the one sending them, also simple instructions from a reliable authority explaining what to do in case of accidents of various kinds. Almost everyone has read such instructions (more or less reliable) at some time or other, but when the time comes to use them we find we have forgotten them; but with these cards constantly about the factory, some will become familiar with their contents or at least someone will have read them recently enough to know what to do when the accident happens. Now I hope some one will take up this plan and perhaps improve upon it, and I believe some one will, not only for his own good, but for the good of humanity. R. Earl Weinland.

Indianapolis, Ind.

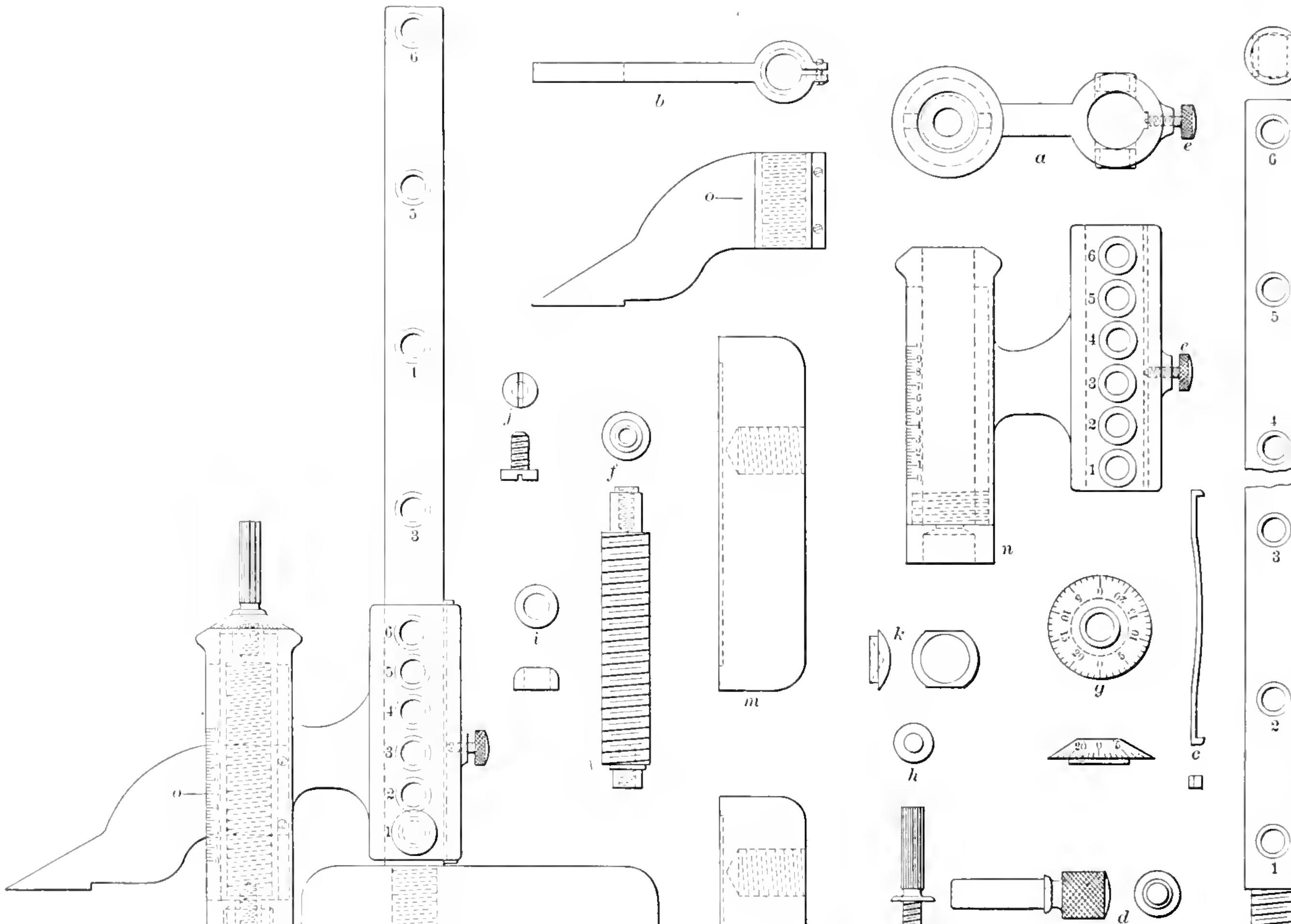
SIX-INCH MICROMETER SURFACE GAGE.

Editor MACHINERY:

MACHINERY is looked over every month by many who are seeking for new ideas in toolmakers' gages, etc., and I must confess to being guilty in this respect, also. We toolmakers as a class are particularly interested when a tool described is not on the market, for we then know that we may be of a few to make such a tool to add to our collection. The tool shown herewith is one of my own design, and having used it successfully on various kinds of work, I can recommend it as an appropriate addition to any toolmaker's collection.

The tool to be described is a 6-inch micrometer surface gage, and is shown in the cut, which includes the assembled parts and the details. It can be quickly set to exact positions, varying by 1 inch from 1 to 6 inches in height, by inserting a hardened plug. A valuable feature of the tool is the set of six independent holes through both the movable part and the beam. Each hole is bushed with a hardened steel bushing, ground and lapped to fit the plug which locates to exactness the various inch settings. In the beam hole is cut a slot 5-32 inch wide to fit the spring gib, *c*, which holds the slide in position when the lapped plug, *d*, is withdrawn.

When the tool is assembled, the scriber, *b*, is set to zero, and fastened with a thumbscrew, *e*. Then, using the standard length gages, 1, 2, 3, 4, 5 and 6 inches long to get the positions, six holes are drilled and reamed through the slide and beam at the same setting. The same operation is performed when lapping, after the bushings are placed into the beam and slide. An important part of the tool is the threaded screw, *f*, the construction of which requires great accuracy. To make sure that the lead is perfect, when the last cut is taken go over the work three times with the tool in exactly the same position, using a magnifying glass to see whether the tool cuts any at either side of the thread; if not, it may be assumed that the lead is all right. The diameter of the screw is ⅜ inch, and it is cut with a lead of 1-20 inch. At the bottom end of the screw is fitted the piece *i*, which is hardened and ground. The curved part of *i* acts as the forward bearing of the screw, being seated in the 45-degree counterbore in the body, *a*. At its upper end is fitted the graduated barrel, *g*, and the speeder, *h*.



Parts of a Six-inch Micrometer Surface Gage.

Referring to the details, the movable part, *a*, of the instrument is made of tool steel. The two holes in the body for the movable scriber, *b*, and the beam, *l*, should be bored at one setting on the angle-plate, in order to secure perfect parallelism, which, of course, is necessary for accurate measurements. The hole for the scriber should be 1-64 inch large, but the hole for the beam should be a perfect sliding fit. The bottom of the hole for the scriber is closed by a piece, *n*, screwed in. This piece is bored out with a 45-degree counterbore to form a bearing for the lower end of the screw, and is hardened and lapped in the bearing. The threaded part is 11-16 inch diameter, 40 threads per inch. A slot ⅛ inch wide begins 5-16 inch from each end, and is carried through into the wall on the opposite side of the hole as indicated by dotted lines. In these grooves slides the movable scriber, *b*. There are forty divisions along the side of this slot 0.025 inch apart, these giving the tool a range of one inch with micrometer measurements between plug settings.

The sliding scriber, *b*, is made of tool steel hardened, ground, and lapped on the point, and combined with it is the micrometer nut, which part is drawn to a spring temper. This nut is split and adjusted by two small screws to compensate for wear. On the scriber is the zero mark, which forms the datum line from which the measurement is taken. To make a neat appearance, the cap, *k*, is placed on the bottom end of *a*, where it is held in position by being made to fit tightly to the bored recess. The setting of the tool is accomplished by loosening the speeder, *h*, and turning the barrel on the screw. When the adjustment is made, the speeder is again tightened down, thus locking the screw and the barrel together. The beam, *l*, is screwed into the base block, *m*, down to a shoulder. One of the most particular points to be observed when building a gage of this design is not to have the bushing holes in perpendicular alignment. With this precaution the plug, *d*, will enter no other hole than the corresponding holes in the beam and head for which it is intended.

L. NORDEN.

INSERTED BLADE CUTTER CONSTRUCTION.

Editor MACHINERY:

An article in the April issue of MACHINERY about inserted blade milling cutters attracted my attention and reminded me of an inserted blade milling cutter which I saw in the exhibit of the Pratt & Whitney Co. at St. Louis last summer. In my opinion the method used for securing the blades to the body in this particular cutter was the simplest and most effective that I have run across. As the construction of these cutters may not be familiar to many of your readers, I hereby submit a description and explanatory sketches of same.

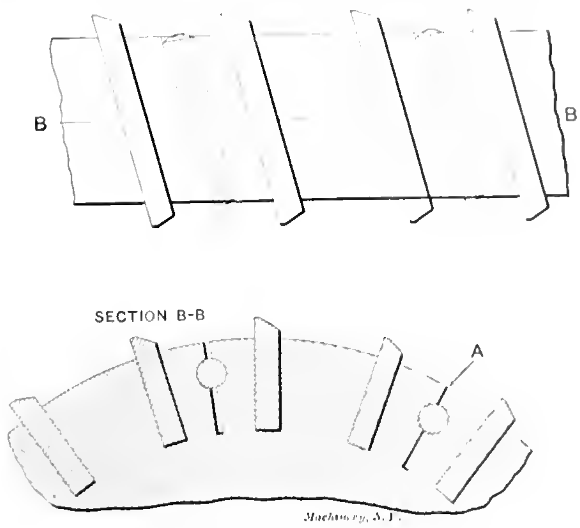


Fig. 1. Pratt & Whitney Method of Securing Blades to Body of Axial Cutter

Two kinds of cutters were exhibited, one with blades set into the body on an angle with the axis of the cutter, and another with the blades parallel with the axis or center line. The former was to be used for face milling; the latter for end milling. The blades in both, however, were secured to the body by the same method.

As will be seen from the cut, the blades are set into rectangular slots in the body and held in position by means of taper pins which wedge the metal of the body firmly against the sides of the blades. There is only one taper pin for every other blade, the pin spreading the metal equally on each side of a narrow slot *A* located half way between the slots for the blades. My attention was called to the fact that the distances between the teeth must be such as to insure on the one hand perfect holding qualities (that is, the metal between the slot *A* and the slots

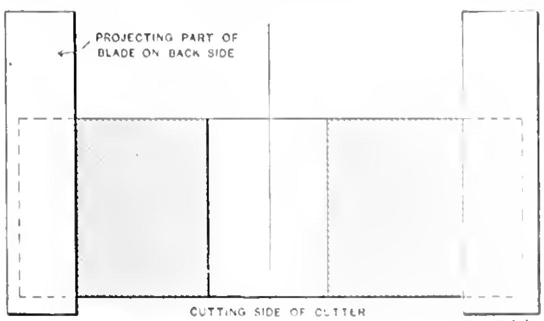


Fig. 2. Section of an End Milling Cutter

for the blades must not be too heavy to allow good springing action when forced sideways by the taper pin), and on the other hand a strong and durable body.

On the cutter with the blades inserted on an angle the taper pins and the slots *A* were also, of course, on an angle, being parallel with the blades. This angle seemed to be about the same as the angle generally used on solid spiral fluted milling cutters, or about 15 degrees. Another feature that I observed on the cutters to be used for end milling was that the blades were projected quite a considerable amount on the back side, allowing for adjustment when the cutting faces of the blades were worn down near to the body. H. D.

AN EXPANSION CHUCK.

Editor MACHINERY:

In the March issue there was shown an expansion which I know to be a very good tool, and as its similar is so close to the one I designed about a year ago, I thought it might be of interest to some to show same. The work it was designed to hold was the very same as described in the aforesaid article, *i. e.*, brass-lined cast iron cylinders.

As will be seen, the jaws, *F*, are operated by the handles, *G*, which are fast on the cam ring, *B*; the cam ring in turn is held in position by the drive ring, *C*. This ring also serves to close the slot in the body of chuck through which the ⅞-inch square piece, *E*, transfers the cam motion to the centerpiece, *D*, which in turn acts upon the jaws, thus expanding same in cylinder. A coil spring, *M*, is placed at the lower end of each jaw, which is covered by a cap, *J*, and a circular spring, *L*, engages in the

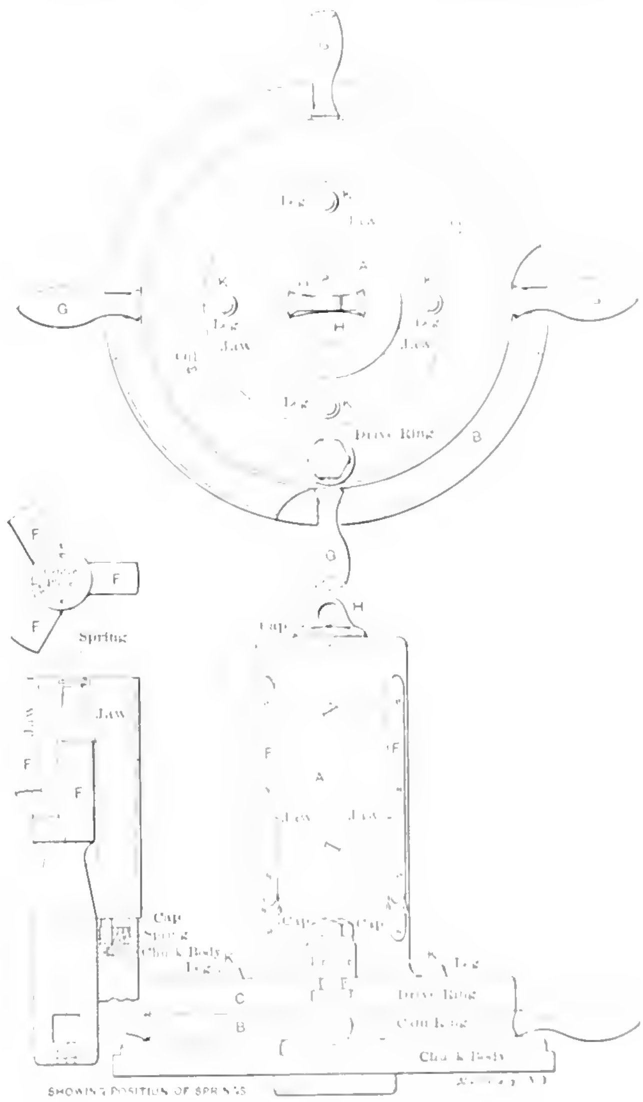


Fig. 1. Center Piece with Jaws and Springs in Position. Fig. 2. Plan and Elevation of Assembled Chuck

three jaws on the top, which serves to contract them when the cam ring is released. The tapped holes in the jaws are used when cylinders of a different size are to be faced as adapting jaws are placed in position. Fig. 2 is a drawing of the assembled chuck. Fig. 1 shows the centerpiece with jaw and springs in position, and Fig. 3 the parts in detail. The cap on top of the chuck serves to close the opening and as a hold for the hoisting hook, so that the chuck can easily be lifted on and off the machine. J. M. STAPF

Rochester, N. Y.

SOMETHING ON THE HEAT QUESTION AS AFFECTING THE ACCURACY OF MACHINE OPERATIONS.

Editor MACHINERY:

Our meetings were hardly of the A. S. M. E. class, but they were generally entertaining and often instructive. There was never any formal notice of a gathering, but sometimes after

dinner as we sat talking and smoking in the dining room attached to the works, one of us would introduce a subject either from his own experience or culled from the press. Then an easy flow of criticism or recital of experiences would follow till the bell event, to be continued if unfinished on the next day. Once a subject was mentioned, we generally managed to keep the conversation rolling for a while; we had most difficulty in finding new things to talk about. As may be expected, there were not many of us. Most of our fellow diners had enough—or too much—work in working hours to worry themselves with it in their spare time.

At one of our meetings the subject of keeping work of a precise nature at one temperature was discussed. It was introduced by a bluff old fellow, who though a thorough mechanic, had a slight disdain for things scientific. He read a paragraph out of a paper describing how a screw-cutting lathe at the British national laboratory was installed. It seems that the lathe house proper is made of glass and is air tight. It is entirely surrounded by an outer house, the intervening space being filled with the heating and driving apparatus. Hot air is used to control the temperature and the lathe is controlled by electric switches in the outer house. No one is allowed in the inner room when the lathe is in use lest the heat of his body should affect the work in progress. This, he contended, was absurd, as many other things would affect the result in quite as great a degree as the heat of a person's body. The heat of the spindle bearings, the heat generated in the work itself, or the wear of the tool would all put in errors, even if the accuracy of the lathe guide screw was up to it, which he doubted. There was not much discussion on this as no one had any experience anything approaching to this in accuracy, but the majority who had anything to say seemed to be inclined to agree with him. However, it drew forth an experience interesting enough to present.

The relater was at the time it took place charge hand over a number of machines, amongst which was a milling machine, whose operation was to finish mill a thin rod to length. The rod passed between two side mills, whose distance apart determined its length. The error permitted was very small. The rod was about 8 inches long and had a fair amount of milling on it before this stage. When the job was started he was worried by the number of wasters returned by the inspectors, short in length. The error ranging from 2 to 4 thousandths. It was not an occasional lot that was wrong, but out of the majority of lots that went up, three or four were returned. First thoughts were that the cutters might be loose on the mandrel, but that was very soon dismissed. Then he thought that the work was not put in the jig properly, the rods projecting too far one way, which would take too much off one end without touching the other. But on testing it was found that too much had been cut off *both* ends. This was a problem. However, while watching the machine in operation shortly afterwards, the cause suddenly struck him. The lubricant used was a very thick oil and to remove this before the final operation, and the cuttings which clung to the work, he had installed an open kettle, filled with water and soda, heated with a small gas stove. The rods were put into perforated cans, dipped into the kettle, and after the can was given a shake the rods would be fairly clean. Upon looking into the kettle he found the water nearly at boiling point, and hung inside was a can full of rods evidently waiting for the operator. He hovered around awhile and saw the operator take the can out, and with the aid of some waste catch hold of a rod, clap it in the jig, tighten up and start the feed. Taking the coefficient of linear expansion of the metal at 0.000007 and the increase in temperature about 90 or 100 degrees, the expansion in the rod would more than cover the discrepancy between the rod and its gage. The temperature of the water was lowered, and it was pointed out to the operator the evil of milling the rods while hot; afterwards he had no trouble.

McAnic.

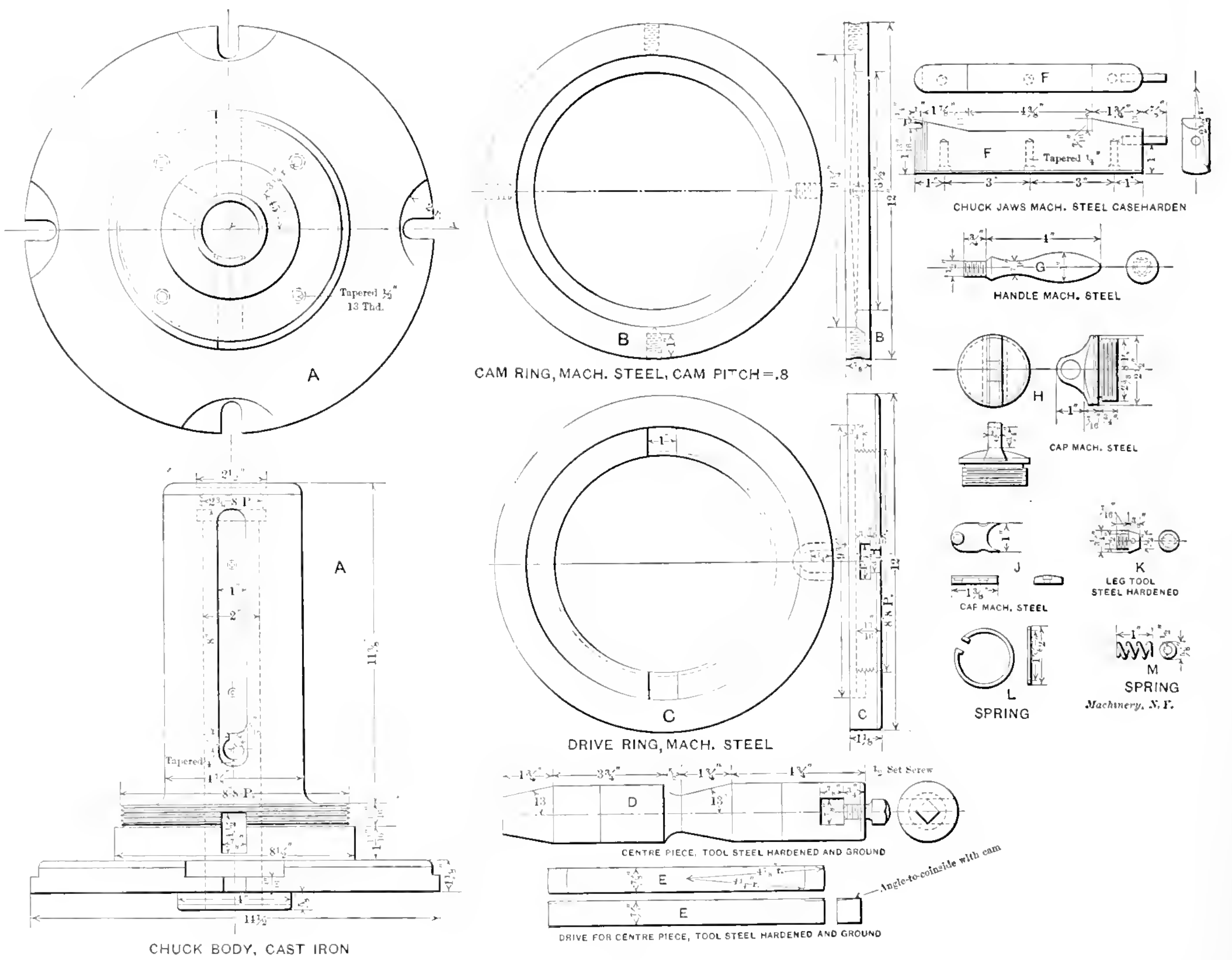


Fig. 3. Parts of Expansion Chuck.

SOME PERSONAL REMINISCENCES.


Joseph H. Springer, Sr.

Editor MACHINERY:

I have read a number of articles in our trade papers from the pens of present-day mechanics that are misleading to the reader; as, for example, when the reader is told that the craft of pattern making was unknown forty years ago. This is a mistake, for even when the flour mills were built on the Brandywine River, James Rice had an iron and brass foundry in Wilmington, Del.; Malon Betts, of the same town, employed pattern makers and molders one hundred years ago; and nearly as long ago Bush & Bonne made carwheels there. When I went as apprentice to Evan C. Stotsenburg in the spring of 1849, there were four large iron foundries in Wilmington. Stotsenburg's was the largest, employing, on an average, 8 to 10 patternmakers and 50 to 70 molders. Every man in the pattern shop had served a five years' apprenticeship, and had papers to show for it. The journeymen in the foundry were all good molders, able to make castings in green sand, dry sand, skin dried, or loam. We had in the foundry several steam jib cranes, two large core ovens, two large cupolas, and other tools. The cranes and cupolas were equal to any that are in use to-day in the most modern plant. The blast for the cupola was from a pair of twin blowing engines, and molders did not stop working when the blast went on, but gave a helping hand to any shopmate who was a little behind. Molders' and machinists' wages between 1850 and 1860 ranged from $10.00 to $12.00 per week, patternmakers receiving about 10 per cent. more. I say without fear of contradiction that mechanics did a fifth more work during the years I have named than they do at the present day, notwithstanding the many improvements in machinery and the present higher wages. Many of my readers will say: "We do better work now than did those old 'has-beens,'" but your work is not even as good.

In those days an apprentice was bound to his employer, and in many cases had to live with his master during the term of his apprenticeship. I served two-and-one-half years in the pattern shop, and the same length of time in the machine shop, receiving $2.50 per week from first to last. In common with other apprentices, I had to open and close the shop before and after working hours. For six months my work was cutting bolts with stock and dies. We had only one power bolt cutter, run by the engineer, who also attended to his engine and did his own firing, for which he received $1.25 per day of about 12 hours. The tools in the machine shop were very crude. Most of the lathes had endless chain feed, and the planers had a screw the full length of the bed, working through a nut bolted to the under side of the table. Drill presses had no power feed. Taps were made on a small lathe with hook tool and chaser in the hands of a skillful mechanic. In addition to this foundry, Wilmington had two machine shops. Harlins & Hollingsworth, the larger, employed from 800 to 1,000 men. They built passenger cars and steamboats, and had a large business in their machine shop.

In the spring of 1858, I moved to Philadelphia, Pa., and went to Wm. Sellers & Co. as a patternmaker, receiving $14.00 per week. It is not out of place to say here that the man who worked at the next bench to me, Mr. J. K. Jones, is still in the employ of the firm as foreman of the pattern shop, a position he has held for forty years. There were then about 250 men in the machine shop, 25 in the blacksmith shop, and 1[illegible] in the foundry, of whom 18 to 20 were patternmakers, a total of nearly 400 men besides the office and drafting room force. One man took all the time, booked it, and made out the payroll. According to the rule then followed in both Wilmington and Philadelphia, the men were paid in gold and silver on Saturday after working hours, up to the preceding Friday night. All was harmony between men and master, there was no red tape and no striking.

When I entered the employ of Wm. Sellers & Co., I found a shop system that is unequaled at the present day in any plant. When a machinist was employed, he reported to the storeroom for tools. If he was a vise hand, he told the storekeeper his vise number. The storekeeper went to his vise, unlocked his drawer, checked up his tools to make sure that they were in good order, and the man receipted for them. When a tool was broken or worn out, he returned it to the storekeeper and secured a new one for it. This rule held all through the shop. In the foundry a record of each molder's work was kept by the boss laborer in the cleanings shed, good castings being placed to his credit and bad castings charged against him, so that the firm could soon tell if he was a profitable man to employ. The flasks were all of iron, and a flask of any size could be made up at short notice.

I find very few all-round mechanics in the present-day machine shops; a man is either a lathe, planer, or boring-mill hand, and the same is the case in the foundry, a molder is a green sand, dry sand, or snap molder. If he is a green sand molder, he must have a pattern, flask, cope, and drag. If the foreman tells him to bed a pattern, he is lost, and there are only a few who know how to make a casting without a pattern. Loam molders are one in a thousand. If you find an all-round molder in a city foundry, you will find either a man who has served his time in some small town or one of the old "has-beens." I trust the time is not far distant when a boy will have the opportunity to serve his time at his trade as his father did. A few years ago I was in an Eastern machine shop that build a number of standard tools, such as small lathes, milling machines, etc. The gentleman who showed me through the plant, also showed me the stockroom. Here I saw the parts of the tools all stacked up after they had passed the milling machine. I said: "I presume these parts are now ready to be assembled." He smiled and said: "You know, Mr Springer, we build very fine tools. These parts all go to a department where they are run through very accurate planers, they are then assembled and tested." This the milling machine and handyman, made from a laborer, cannot do, hence I found that even now manufacturers who build and turn out good work must at the end have some skilled mechanics.

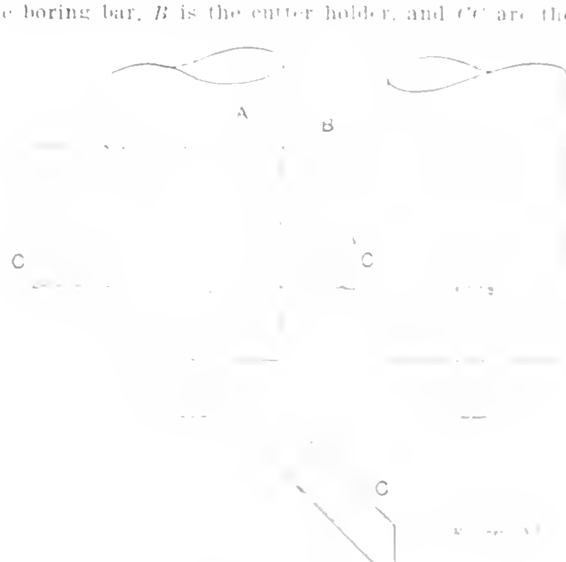
Louisville, Ky. JOSEPH SPRINGER, SR.

Joseph H. Springer, Sr., was born in Wilmington, Del., 1834. He is a lineal descendant of the original Swedish colonists in America, the American history of the family beginning with Carl Christopher Springer, of Stockholm, Sweden, who settled at Wilmington, Del., in 1646. Mr. Springer served a six years' apprenticeship with Evan Statsenberg, who had a foundry and machine shop in Wilmington; two and one-half years were served in the machine shop, two and one-half years in the pattern shop, and one year in the drawing room. At the expiration of his apprenticeship he was made general foreman, and this position he filled two years. He has since worked for William Sellers & Co., Bement & Dougherty, the Bethlehem Iron Co., the Edge Moor Iron Co., the Keystone Bridge Co., the Niles Tool Works, Fraser & Chalmers, and others, for which firms he has served in the capacity of foreman, draftsman, machinist, mechanical engineer, superintendent and owner. Mr. Springer has been prominently connected with interesting engineering work, particularly with the erection of the Kentucky River viaduct in 1876 to 1877, which demonstrated to American engineers for the first time, it is said, the important advantages offered by the cantilever bridge, in permitting erection without false works.

ADJUSTABLE BORING TOOL.

Editor MACHINERY:

The cut shows a new adjustable boring cutter in which *A* is the boring bar, *B* is the cutter holder, and *CC* are the two



Adjustable Boring Tool

cutters of self-hardening steel. Two dovetail slots are milled out on opposite sides of the cutter holder at the angles shown. Into these dovetails are driven the self-hardening cutters *CC*. They are then ground off on the ends to suit the required diameter of hole. The advantage of this style of cutter lies in the fact that when the cutters have worn they can be easily driven out and reground to size. Experience shows that no fastening for the cutters is required since the angle at which they are set was chosen so that the natural tendency of the cutter to back out is eliminated. This cutter holder has been in use at the shops of the Alliance Machine Co., Alliance, O., for some months with most satisfactory results.

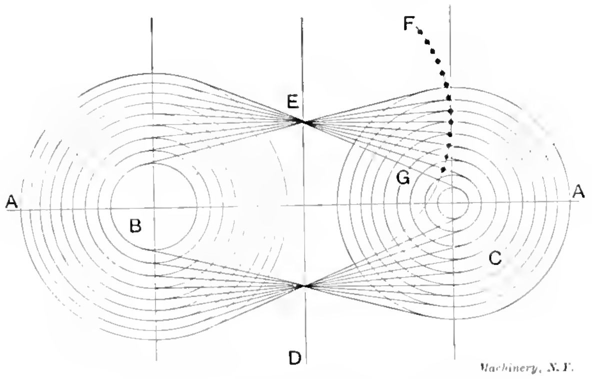
Alliance, O. F. A. Hobbs.

GRAPHICAL METHOD OF LAYING OUT CONE PULLEYS.

John Swanberg.

Editor Machinery:

My graphical method for laying out a pair of cone pulleys is as follows: First draw straight line *A A* supposed to connect the centers of the cones to be laid out; then set off the centers of the cones *B* and *C* on line *A A* (full size is best); then bisect the distance between the centers of the cones and draw another line *D E*. Now assume the size of the two cones—say the largest is 25 inches and the smallest 3 inches diameter. Then draw a line tangent to the circles, or the line representing the inside of the belt *G*, which will intersect the line *D E* at *E*, and taking the point *E* for a center scribe the circle *F*. Then divide the circle *F*, commencing at the line of the belt *G*, into as many parts as needed, of a length to suit the required speeds. Draw the other radiating belt lines through the point *E* and the divisions on the circle *F*, extending them toward the cone *B*, and they will be the inside of the other belt lines. Draw circles tangent to these lines and you will have all the diameters of the rest of the steps of the cone to match the first, and the belts will all correctly fit the steps. This is only an approximation rule, but it is much closer than other diagrams for the same purpose.



Graphical Method of Laying Out Cone Pulleys.

Pearl River, N. Y. John Swanberg.

SEEN IN A JOBBING SHOP.

Editor Machinery:

Among the many comical occurrences which I have witnessed in my wanderings as a journeyman, I will mention the following. An inventor (a would-be all-around mechanic) had occasion to drive a hardened dowel pin, and being in a hurry (as most inventors are), he failed to see a hammer near enough to suit his Royal Highness. He simply picked up my 6-inch hardened steel square, grasped it by the beam, and using it as a handle and the head as the hammer proper, he started in, but, needless to say, I did a little starting in on my own hook.

Two other "stunts" I witnessed which caused me to laugh good and plenty (because the tools "abused" weren't mine) were using a one-inch micrometer as a C-clamp, and a 3-inch vernier as a monkeywrench. I have also seen a 6-inch flexible steel scale used as a scriber. The above may sound quite "fishy," but they are facts nevertheless. All of the above were the acts of "inventors" who no doubt took things for granted.

R. A. Lachmann.

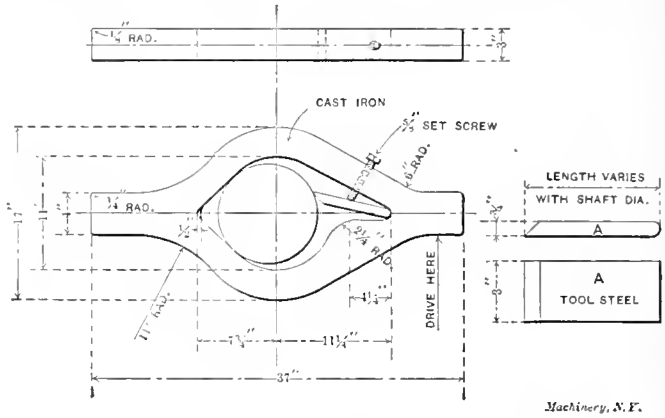
Chicago, Ill.

John Swanberg was born in Hernösand, Sweden, in 1863. He served an apprenticeship in the shipyard of his native town, and has since been employed in this country by the A. B. See Mfg. Co., Yale & Towne Mfg. Co., C. W. Hunt Co., American Brake Shoe & Foundry Co., and the Dexter Folder Co., with which concern he is now identified. His forte is ornamental pattern work for castings of all descriptions.

LATHE DOG FOR HEAVY CUTS.

Editor Machinery:

The cut shows a lathe dog which I have used for years in turning large forged shafts where heavy cuts are to be taken. I have taken cuts of 1½ inches without slip; in fact it positively will not slip. The cut will show the construction clearly



Lathe Dog for Heavy Cuts.

so that little explanation is necessary. The frame is made of cast iron and the driver *A* is of tool steel, made in different lengths to suit the work to be turned.

J. Mayer.

Monongahela, Pa.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

Editor Machinery:

Answering question No. 42, by H. F. S., in "How and Why" column, I would suggest that the inquirer use brass forms instead of iron, as the acids used in tanning discolor the leather when brought in contact with iron; in dampening or wetting the leather be sure and change the water frequently, or better still, use running water. The roughness he complains of depends on the firmness or quality of the stock used and cannot be avoided altogether unless the crimps are formed or pressed with the smooth or hair side out.

Seneca Falls, N. Y. James Maltby.

47. H. J. R.—Please give me a receipt for tempering circular saws used in cutting metals. The saws are made from 4 inches to 6 inches in diameter and about ⅛ inch thick. How can the warping of saws be prevented or how can they be straightened after warping?

A.—We refer this to our subscribers. Our inquirer, however, will find under shop kinks in the May number, a suggestion for hardening thin saws without warping, also in "The Treatment of Steel" by E. R. Markham, published by The Derry-Collard Co., 256 Broadway, New York, some practical advice on hardening and tempering saws. In "Saw Filing and the Management of Saws," by Robert Grimshaw, published by Norman W. Henley & Co., 132 Nassau St., New York, there will be found information in regard to hammering saws.

48. L. J. H.—I propose to construct a train of helical gearing in which a driving gear, an intermediate gear and pinion and a high-speed pinion will be used, as shown in Fig. 1. The intermediate gear and high-speed pinion are cut 20 pitch and at an angle of 32 degrees. The question is: To what degree angle should the driving gear, *D*, and the intermediate pinion, *C*, be cut in order to exactly counterbalance the lateral thrust of gears *A* and *B*?

Answered by Mr. E. H. Fish.

A.—A spiral gear acts as a wedge; in Fig. 2 we have a wedge shown more acute than our gear, to be sure, but acting on the same principle. If we push the wedge with a force M, it will spread apart any two pieces between which it may be placed, with forces A and B acting at right angles to the two faces. These forces have to bear a certain relation to each other known as the parallelogram of forces shown in Fig. 3 which is obtained by laying off M in some convenient scale, say 1 inch for each pound, laying off A and B from O in directions perpendicular to the surfaces of the wedge and making them long enough so that they will make sides of a parallelogram as shown. Then, if A and B are measured with the

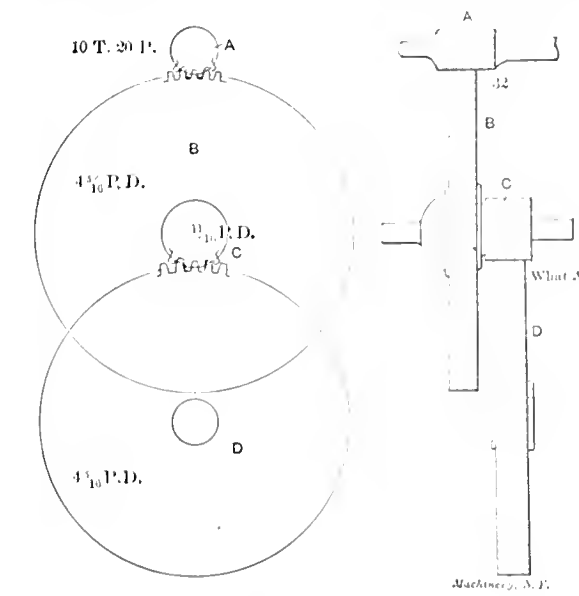
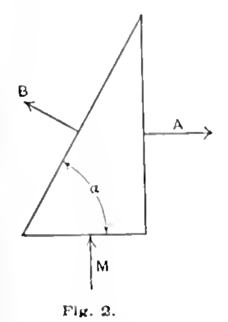


Fig. 1.

same scale with which M was laid off, we will find the pressure required. A corresponds to the force acting lengthwise of the shaft if the wedge is made of the same angle as the teeth of the gear. As gear tooth angles are usually measured, they correspond rather to the angles marked α in Figs. 2 and 3 than to the angle of the point of the wedge. From Fig. 3 we see that force $A = M \tan \alpha$. In the case cited, the force M is the pressure acting at the pitch line at right angles to the shaft. It would appear from the above equation necessary to know this force in order to get force A. But we really do not need to know what A is so long as we only have to make it equal to a similar force, A_1, acting in the opposite direction along the shaft. For the other gear we would have



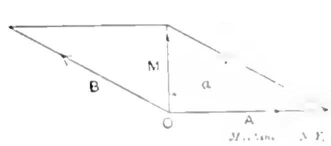


Fig. 2. Fig. 3

a similar equation, $A_1 = M_1 \tan \theta$, where M_1 is the force acting on the pitch line of the gear at right angles to the shaft and θ is the angle of the teeth on gear C. Since A and A_1 must be equal, we have $M \tan \alpha = M_1 \tan \theta$ where we know α to be 32 degrees, but do not know either M or M_1. But leaving out friction we know that the pressures on the pitch line of B and C will be in inverse ratio to their pitch radii or diameters, which in this case is 11-16 inches to 4 5-16 inches or 11 to 69. Changing the last equation to read $\tan \theta = \frac{M}{M_1} \tan \alpha$, and substituting 11/69, for $\frac{M}{M_1}$, and .625 for $\tan \alpha$, we get $\tan \theta = 0.1$, which corresponds to an angle of 5¾ degrees.

J. F. D.—Kindly inform me how to temper cold chisels to chip rough edges on chilled-iron castings. Also what shape of point or edge to use.

Answered by Mr. E. R. Markham

A.—The chilled iron castings referred to I take to be castings whose thin projecting surfaces are hard. Where there is no danger of breaking down into the portion of the iron we wish to save I have had excellent results from grinding the chisel perfectly flat on end as shown in Fig. 1, thus breaking the projections off rather than attempting to cut them.

If, however, it is necessary to make the chisel of a form that will cut, I have had best results with the form shown in Fig. 2, where the surfaces that make the cutting edge are rounding instead of flat, as is usually the case, and the included angle of these surfaces instead of being about 70 degrees, as is usually the case with a flat chisel used for cutting ordinary grades of stock, is nearer 85 degrees if it is possible to state an angle where the surfaces are rounded as shown.

However, the important part of making a chisel which must stand rough usage is the forging and hardening. When forging chisels for work where extreme toughness is desired, I am an advocate of the use of resin, dipping the heated chisel

FIG. 1

FIG. 2

in powdered resin before the final hammering to shape. Hammer with light blows as the steel cools. Do not use any high heats; just *good forging* heats for tool steels.

After forging, I believe in re-heating to a low red and then laying one side till the red has disappeared, when it may be re-heated to a low red and quenched for hardening. Do not use *cold* water for this, as the steel is made too brittle by so doing, and is no harder than if hardened in water which has been heated somewhat—from 60 to 100 degrees F.

When dipping in the water it is a good plan to dip somewhat deeper than the point we desire to harden to, then gradually raise the chisel to the desired point; doing this we do not have any line where the metal is hard on one side and unhardened on the other.

When drawing the temper, check in oil rather than water when the desired color is obtained; the exact color cannot be stated arbitrarily. A deep brown with red spots will probably prove all right, provided proper heats were observed when forging and hardening; if heats too high in temperature were employed it will be necessary to draw the temper more.

When I wish a very tough chisel I prefer the following solution as a hardening bath rather than water, but care must be exercised in its use as it is a deadly poison: To six quarts of *soft* water add one ounce of corrosive sublimate and two handfuls of common table salt. When dissolved it is ready for use. Tools hardened in this bath do not require the temper drawn as much as if hardened in water, and tools hardened in water that is warmed somewhat do not need drawing as much as if hardened in cold water as they are not as brittle.

• • •

A correspondent of the New York *Times* suggests the not entirely novel idea of utilizing the power of Niagara Falls at night and letting the waters flow in their pristine grandeur during the daylight hours. In other words he would utilize the Falls to their full power during the night and give the tourist his money's worth during the day. But what the ultimate fate of Niagara Falls will be is a problem. The commercial tendency of the age will apparently make it almost impossible to defend this gigantic water power from the greed of corporate interests, which will be immensely benefited by its exploitation. A conservative estimate of the value of the power represented by the water falling at Niagara is not less than $100,000,000 yearly, and this figure means the rate of only $15 per horsepower year, or less than one half the conservative rating. The fact to be remembered is that to whatever extent Niagara is exploited, it by right belongs to the whole people, and any benefit to be derived from its immense power should accrue to them, and not to the great profit of corporate interests. In other words, the time of giving away franchises of great value, and in perpetuity at that, has passed.

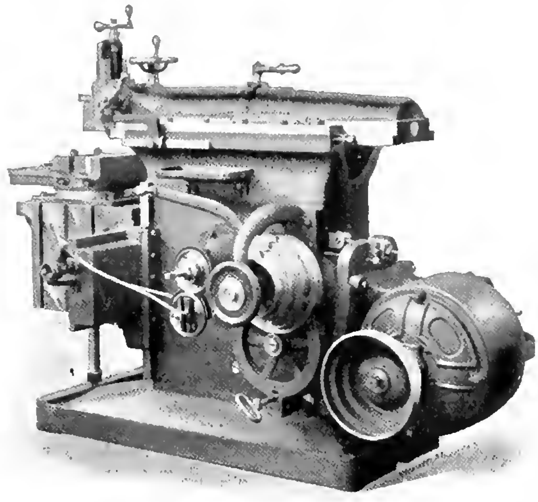
MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

TWENTY-FOUR-INCH CRANK SHAPER WITH MOTOR DRIVE.

The Cincinnati Shaper Company, Elam Street and Garrard Avenue, Cincinnati, Ohio, have brought out a 24-inch back-geared crank shaper, and one of these tools, having a motor drive as shown in the illustration given below, is now on exhibit at the Liege Exhibition, Belgium.

In the motor-driven machine the initial shaft, or shaft immediately below the four-step cone on the machine in the illustration, is driven from the motor by means of a pinion on the cone shaft meshing with a large gear on the initial shaft. In the belt-driven machine the cone pulleys are mounted on the initial shaft direct. In the machine illustrated the motor is of the constant speed type. The small wooden hand wheel on the cone shaft is for adjustment of the ram by hand, and the rod immediately below the large gear wheel is for changing the back gears in the machine, while the curved handle at the side of the machine operates a brake on the inside of the cone pulley. The leaf carrying the motor is hinged at its lower end, and is adjustable for the purpose of tightening the belt through the cap and setscrews shown.



Twenty-four-inch Motor-driven Crank Shaper.

The shaper is of rigid construction and is built by a system of jigs, insuring accuracy. The cross traverse screw is provided with a graduated collar reading to .001 inch and is also provided with a variable automatic feed, all feeds being obtainable while the machine is running. The head swivels to any angle and is graduated, and the down feed screw is provided with a graduated collar also reading to .001 inch. Full length taper gibs, adjustable endwise by single screws, are provided throughout. The ratio of gearing for the machine when single geared is 6 revolutions of the cone shaft to one stroke of the ram and when back-geared is 26 to 1. The outer support as shown is regularly furnished with each machine; this support is stiff and the surface on which the support rolls is truly parallel with the travel of the table. Ball bearings are provided under the elevating screw to the rail, this screw being of the telescopic form. The vise has a graduated swiveling base. The length of stroke is changed from the working side of the machine, and its position by means of a hand wheel on top of the ram; these changes may be made while the machine is in motion. An opening through the column under the ram provides for key-seating shafts up to 4 inches in diameter. Power down feed, revolving table, tilting table, tilting top for table, cone arbors, concave attachment, mould makers' vises, motor drives, etc., are furnished at an additional cost.

DAVIS TUBULAR MICROMETERS.

Mr. Frank M. Davis, who for nine years was assistant shop superintendent at the Edw. P. Allis works, is now engaged in the manufacture of tubular micrometers at 220 Oregon St., Milwaukee, Wis., and a set of bar micrometers made by him for the Allis-Chalmers Co., Milwaukee, Wis., is shown in the accompanying illustration. These micrometers measure from 18 inches to 84 inches and are designed for measuring pistons, cylinder heads, gear blanks, and all work that can be measured across the diameter. These tools can also be made into inside micrometers for taking the interior dimensions of cylinders, etc., by reversing the micrometers and mandrels in the frames. Beside the bar micrometers the Davis Company also manufactures bow micrometers, several of the smaller sizes of these tools being shown on the wall in the background of the illustration. The bow caliper is for measuring cylindrical work, such as shafts. The bar micrometer has a special advantage in that it can be used for measuring cylinders while being bored as the calipers will reach around the boring bar.

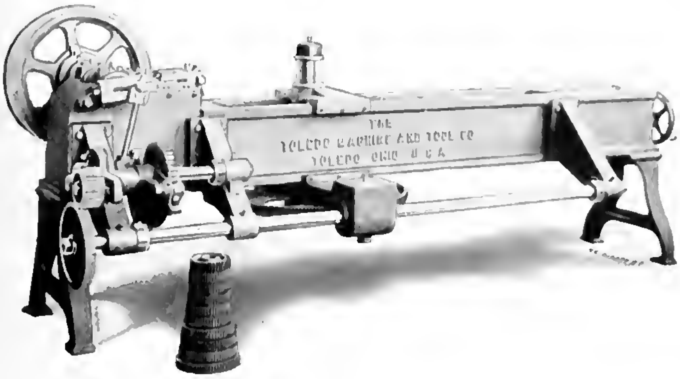
The calipers are made in the form of oblong tapering tubes well brazed, this form possessing the advantages of stiffness with light weight. The mandrel is held in the frame by a clamp bolt by which the mandrel can be secured at approximately the correct place for any given measurement. The micrometer head has a 1/16-inch movement in the frame, and by setting the micrometer at zero the micrometer head can be set to a wire end-measure gage by a nut on the end of the micrometer barrel. After the head is adjusted in this way it is clamped by a clamp bolt similar to that used for the mandrel. These micrometers are in effect comparators, being designed to always be set to standard end measures, this method preventing error through any possible springing to which large tools are liable.

Set of Large Bar Micrometers.

The bow calipers are made in sizes from zero to 3 inches up to 72 inches, and the bar micrometers in sizes from 12 inches to 120 inches. Larger sizes will be made by the makers if wanted, and any of these tools will be sent to responsible firms upon request.

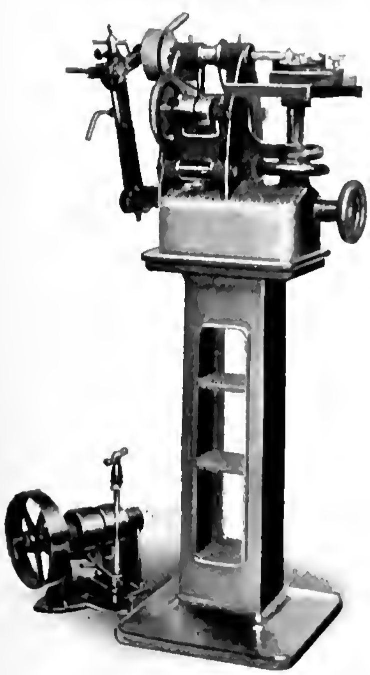
HORIZONTAL NOTCHING PRESS.

A horizontal press fitted with indexing or spacing adjustments for perforating metal rims is illustrated below. The press has a capacity for handling work 96 inches in diameter and for spacing or indexing divisions from 160 to 1,600 spaces. The indexing mechanism is fitted with a worm gear and worm, the makers claiming that this form of driving mechanism largely eliminates the inaccuracies which are often caused by the momentum in large revolving disks. The worm and gear



Notching Press for Steam Turbine Work.

are machined on special tools; the worm runs in an oil-tight box and is immersed in oil. The first driving shaft is fitted with a locking disk which also serves as a ratchet wheel. This wheel is positively locked at each stroke of the press or revolution of the crank shaft, immediately upon the release of the driving pawl. The change gears can be easily removed and various combinations made to obtain the different spacings required. Only one locking disk is furnished, but by means of the adjustable crank head connected by a rod to the locking disk plate, one or more notches may be used in spacing, thus reducing the number of change gears required for making different divisions. So accurate is the indexing and spacing of notched work by this machine that it is not necessary to file or mill the disk slots in packing to obtain uniformly straight grooves even on reversing the disks. The machine has just been designed and built by the Toledo Machine & Tool Co., Toledo, O., for a special line of steam turbine work.



Tap and Die Grinding Machine.

TAP AND DIE GRINDER.

The Greenfield Machine Co., Greenfield, Mass., have brought out a machine for grinding taps, die chasers, chucking reamers, surface work and light hand-grinding, generally. One view of this machine is given in the accompanying half-tone.

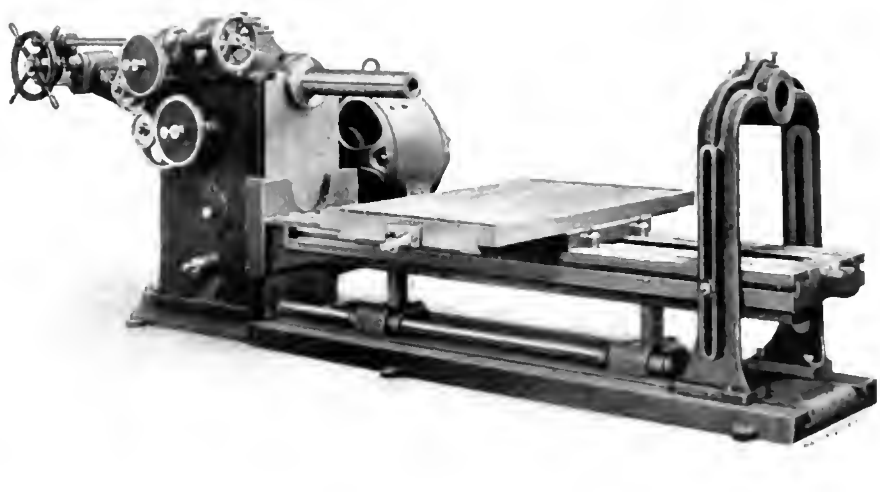
The spindle is fitted into cast iron boxes supplied with oil reservoirs and ring oilers. It has a 4-inch cup emery wheel mounted on one end of the spindle and a wheel holder for disk wheels on the other end. This holder can be easily removed and replaced by a 3/8-inch spring chuck for holding emery sticks, etc. Eight different speeds are provided to accommodate the different sizes of the wheels and there are means for tightening the belts. The table is elevated by screw and the horizontal hand-wheel shown, and when in position, can be clamped. The belt runs direct from a main line to the tight and loose pulleys on the machine, or a countershaft may be furnished.

The machine is fitted with a die-chaser holder and a tap-sharpening attachment. The chaser holder, shown to the right in the illustration, is provided with a gage against which the chasers may be clamped, thus permitting the whole set to be ground alike in relation to the thread, each having the same amount of clearance. This holder is mounted on a swivel base, thus allowing the chaser to be ground at any required angle. The holder is moved by hand across the face of the wheel, using the table guide and the knurled adjusting screw for feeding the work toward the wheel. The holder will grind chasers up to 2 3/4 inches wide, of any length.

The tap-sharpening attachment consists of two center heads mounted on a swinging arm which carries the tap across the face of the cup emery wheel as shown to the left in the view of the machine presented. A sleeve is provided on the swinging arm which may be clamped in any position, thus permitting the tap to be ground at any angle. The tap is indexed by means of a rigid tooth rest, and is held in place on centers, one of which is attached to a spring lever allowing the tap to be removed quickly. Means are also provided for holding a tap which has the ends broken off or one without center holes. The work is brought toward the wheel by means of the hand-wheel at the front of the machine. This fixture will hold all taps from 3/8-inch hand taps to 1 1/2-inch machine taps, and with it chucking reamers can also be ground.

HORIZONTAL BORING AND DRILLING MACHINE.

The Newton Machine Tool Works, Philadelphia, Pa., have recently built a horizontal boring and drilling machine having a 5-inch diameter spindle. The machine is shown in the accompanying half-tone. Six changes of automatic feed are



Newton Horizontal Boring Machine

provided, running in geometrical progression from .0072 inch to .2646 inch per revolution of spindle. The spindle has a movement of 42 inches, has hand adjustment and hand quick return, and is driven by a 10 horse power variable speed motor through back gearing having a ratio of three to one, by a hardened steel worm and phosphor bronze wormwheel of steep lead, with a ratio of 11 to 1. The speed range of the machine is 4 to 1 through the motor and back gears.

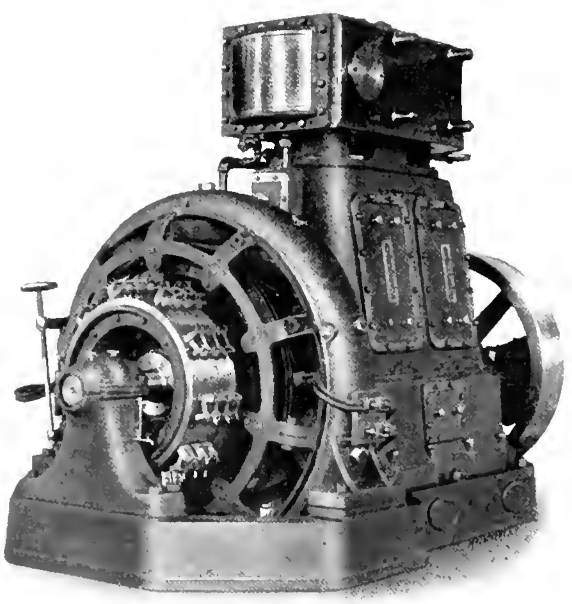
The knee is 26 inches wide x 9 feet long, and is fitted with a carriage 36 inches wide x 60 inches long with a cross movement of 36 inches. An automatic feed and stop may be fitted to the carriage where desired so that the machine may be used for various milling purposes. The elevating screws have both power and hand movements, and are 4 inches in diameter. The maximum distance from center of spindle to carriage is 26 1/2 inches, and from the center of spindle to the knee 32 1/2 inches.

STURTEVANT GENERATOR WITH CROSS COMPOUND ENGINE.

The B. F. Sturtevant Co., Boston, Mass., have perfected a line of small and medium sized generating sets in which the engine and the generator have been designed, the one for the other. In the April number of MACHINERY, we have described one of their generator sets of a type especially suitable for modern yachts and similar service, having a simple engine. Below we illustrate their latest form of generator set, having a vertical cross compound engine. The engine is entirely enclosed, has an oil-tight frame, centrifugal oil throwers, a water shed partition, and a forced lubrication by means of a direct driven oil pump, the oil pressure averaging 15 pounds. The specifications call for a regulation of 1½ per cent from no load to full load, by a Rites governor. The high pressure valve is of the balanced double ported type, with special eccentrically turned snap rings, with sliding joints, the low pressure valve being a flat balanced double ported sliding valve, arranged to lift from the seat. The cylinders are of close-grained, charcoal iron; the crankshaft is forged in one piece with a cast iron counterweight securely bolted thereto, and the main bearings are lined with Sturtevant white metal. All parts are made from templates and duplicates are carried in stock.

The specifications for the generator for this set are very similar to those given in the article referred to in the April number of MACHINERY.

The armature is of the iron-clad, two-circuit, form-wound, ventilated drum type. The armature is balanced both electrically and mechanically. The magnet frame is provided with a vertical adjustment for sizes of 16 K. W. and above. The field coils are shunt and series, separately wound and separately mounted on the pole pieces. The carbon brushes are



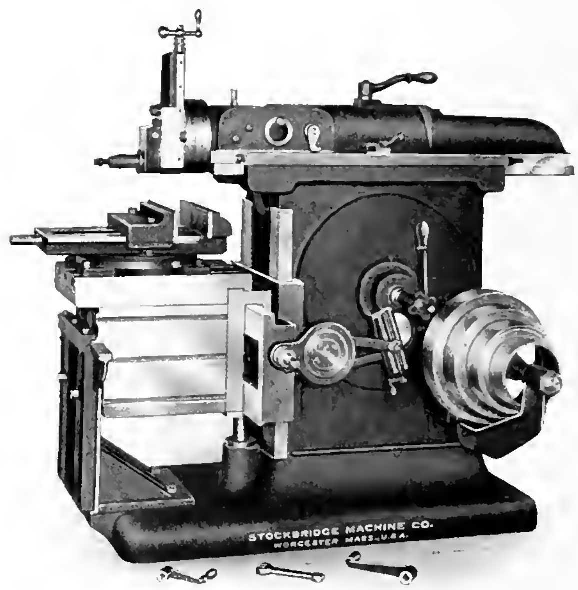
Generator with Vertical Crose Compound Engine.

separately removable and adjustable, and it is so arranged that the point of contact on the commutator remains the same as the brush wears away. The brush holders are staggered to even the wear on the commutator, and are mounted on studs projecting from the brush rigging attached directly to the magnet frame, this ring being arranged to be rotated for adjusting the brushes. The Sturtevant sets are built in a full line of both the vertical and horizontal types, ranging from 3 to 250 K. W. output. The engine and generator are set on the same base in the smaller sizes as in the illustration.

STOCKBRIDGE TWENTY-INCH SHAPER.

The 20-inch shaper recently designed by the Stockbridge Machine Co., Worcester, Mass., is strongly built to stand the usage of high-speed steel. The column is of box pattern, is extended 3 inches on top in front and gives a bearing surface for the ram of 32 inches. The ram is also of box pattern and is 46 inches long by 11 inches wide. An even cutting speed the entire length of the cut and a quick return of 4 to 1 are obtained by the use of the well-known Stockbridge two-piece crank motion, which is a feature of all Stockbridge shapers.

The machine has automatic feeds to both head and table, that are adjustable while the machine is in motion. The head has a graduated swivel which can be set at any angle and clamped in position by two bolts. The slide has a travel of 9 inches. The ratchet wheel for the vertical feed of the tool head is made of steel and its notches are cut to a fine pitch for power feed on hard material. The screw has a graduated collar reading to 64ths of an inch; the collar can be set to read from zero at all times without regard to the position of the screw. The table is of the box form with working surface on top 14 inches by 20 inches, and on the side 14 inches by 15 inches. The outboard bearing supports the table the entire width



Stockbridge Twenty-inch Shaper.

when in any position on the bar. The support engages with the table and is automatically raised and lowered by it. The table is raised sufficiently above the saddle to allow T bolts to be put in from the back as well as from the front. A cross feed of 26 inches is provided and is adjustable while the machine is in motion; it can be operated in either direction. The table hooks over the saddle as shown.

The driving gear is 20 inches in diameter and has a 3½-inch face. The shaper is back geared and has a four-step cone to carry a 3-inch belt. A telescopic elevating screw having a ball thrust bearing is used. The rocker arm is so made that a 4-inch shaft can be passed through the ram for key seating. The vise is of the swivel base pattern, has a graduated base and has steel faced jaws of 12 inches by 3 inches.

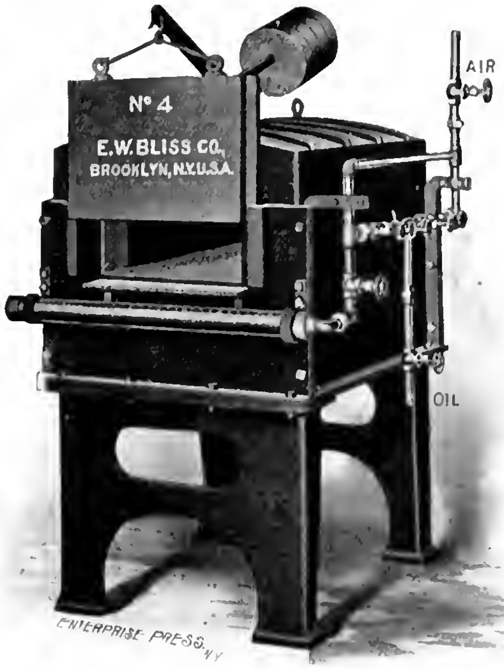
BLISS FUEL OIL-BURNING FURNACE.

The E. W. Bliss Co., 5 Adams Street, Brooklyn, N. Y., who, for a number of years past have made a specialty of building drop hammers, have recently added to their work a new department and are now preparing to equip complete drop forging plants. One of their new departures in this line is the oil-burning furnace intended for drop forging work, which is shown in the accompanying half-tone. Economy of oil was one of the chief considerations in the design of this furnace. The best service with it is obtained by using air as the atomizing agent under a pressure from 15 to 20 pounds. If tool steel is being forged a slow fire is necessary to avoid burning the stock. If soft steel or iron is used, however, the heat can be safely raised to a higher degree and an increased output thereby obtained. In small forging plants a good substitute for an air compressor installation, which is apt to be expensive, can be made by using a pressure blower giving air at about 1 pound pressure. The Bliss furnace may be used with either this or the higher pressure with only a difference in the burner.

A perforated pipe is placed directly under the opening in front of the furnace. The perforations in this pipe are small, running the entire length of the opening, and streams of air

are constantly flowing through the holes; this serves to keep the heat within the furnace and also helps protect the operator when he is removing hot bars or replacing them.

The furnace is made in four sizes. The opening and the interior of all these are of the smallest possible size, not only to avoid the wasteful use of oil, but at the same time to heat the material as quickly as possible. Oil as a fuel has the ad-

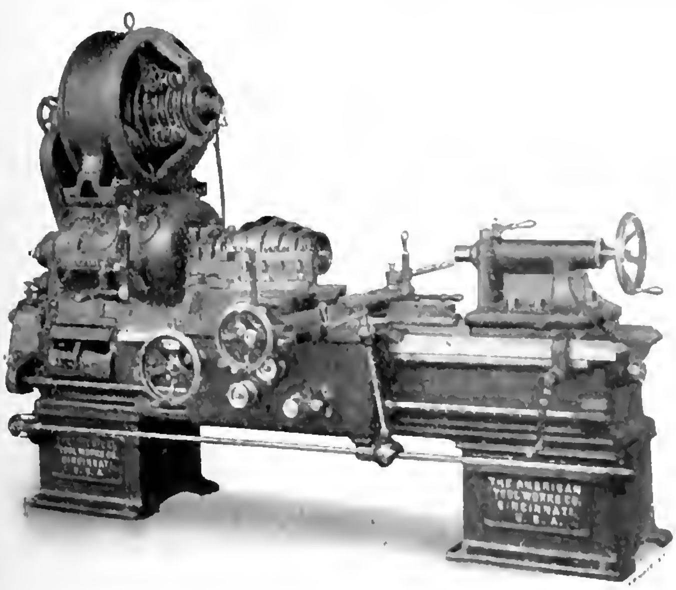


Bliss Fuel Oil-burning Furnace.

vantages over anthracite coal of greater cheapness and the absence of ashes and dirt in the shop. The heat generated by its burning may easily be kept uniform; another economy in its use is that when the forge is no longer wanted the closing of the valve instantly stops expense.

MOTOR-DRIVEN LATHE WITH GEARED HEAD

We illustrate a 24-inch by 8-foot lathe with motor drive through an all-geared head; the machine shown also being equipped with a special multiple tool rest used in the rapid turning of cone pulleys. The motor is of 9 H. P., of the direct current variable speed type, of from 600 to 1,200 revolutions



Twenty-four-inch Lathe with Motor Drive

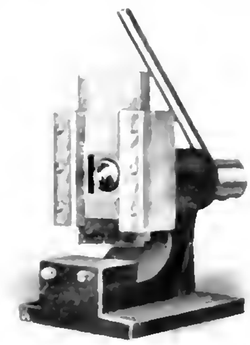
per minute. It is easily started, stopped and reversed by the controller handle placed at the right end of the carriage.

The speeds electrically obtained supplement the fundamental speed changes obtained mechanically through the all-geared head, which is a patented speed-changing device of the makers. This provides for spindle speeds, the ratios of which are 32.5 to 1, 10.8 to 1, 1.31 to 1 and 1.41 to 1. These speeds [illegible] while the machine is in operation by means of the [illegible] shown on the front of the head, which operate positive clutches. Only six gears are used in this device, these being arranged to run at low pitch line velocities, thus reducing the noise incident to all gear drives. Adjustment for speed is determined by reference to the index plate under the front of the head.

This lathe is also equipped with a rapid change-gear mechanism, providing a wide range of changes for feed and screw cutting, each of which may be obtained while the machine is in operation, an index plate showing how to obtain any desired feed. The lathe, although motor driven, may be arranged for a belt drive by replacing the gear on the driving shaft by a pulley. The latter may be of wide face and large diameter, since the belt is not shifted to change the speed, which fact together with the high gear ratio, greatly adds to the power of the tool. The regular carriage equipment consists of a compound rest and a full swing rest. The lathe is manufactured by the American Tool Works Co., Cincinnati, Ohio.

PRECISION BENCH SHEARS

Precision bench shears intended for use by die makers, lock makers, etc., are shown in the accompanying half tone. The shear blade of this tool is 4 inches long, and the shear will split a 1-inch strip through the center; 3/16-inch sheet tool steel seems to be the limit of the capacity of the shear, although 1/4-inch iron has been easily cut with it. Special care is bestowed on these shears during manufacture; the slides are all scraped to a surface plate, the adjustable gibs are finished bright, and the steel blades are ground true on their backs after hardening, so as to give a full bearing when drawn up against the slide by the screws. The motion of the shears is derived from an eccentric shaft, and a lever to be pulled toward the operator.



Precision Bench Shears

The eccentric shaft pin is surrounded by a steel block which works in a slot in the upper slide. The chief considerations in the design of this tool were sufficient stiffness and accuracy in fitting. The shears are made by A. J. Machek, 401 19th Street, Milwaukee, Wis.

TUBULAR MICROMETER FRAMES.

A. J. Machek, 401 19th Street, Milwauke, Wis., is also manufacturing sets of tubular micrometer caliper frames, of which the 3 inch and the 6 inch frames are shown in the accompanying

Tubular Micrometer Frames

cut. These caliper frames are made of high grade sheet steel and are therefore light and stiff. They are intended to be used with the detached micrometer heads now being sold by several makers, one head being required for a set of frames to measure from 0 to 12 inches. The tubular frames are made especially for shops which are now equipped with a system of wire gages. Standards are not furnished regularly with the frames, but can be obtained by those desiring them. The adjustable anvil in the frame is held by friction. The grip, while amply suffi-

cient to hold the anvil when measuring, will slip if the tool should be mistaken for a clamp by the workman. The frames are made in four sizes at present, measuring from 0 to 3 inches, from 3 to 6 inches, from 6 to 9 inches, and from 9 to 12 inches. The frames, in connection with a detached micrometer head, make a set of micrometers of low cost.

GEARED SPEED MILLING MACHINE.

The cuts given below show two views of a positive geared speed milling machine recently put on the market by the Hendey Machine Co., Torrington, Conn., and a sectional view showing the speed and feed works of the machine. This miller differs from the standard machine in that it has a gear cone as shown, instead of a belt cone, on the main spindle for speed changes. With this positive drive a large range of spindle speeds is given, and the full range of feeds is quite independent of the spindle speeds. As shown in the figures, the driving shaft carries a large flanged pulley on the outer end, this pulley being belted either to an ordinary countershaft or to a motor as shown in Fig. 1. Sliding on the driving shaft, inside the base, is the regular form of bracket carrying the driving gear and intermediate gear, the latter not being shown in the cuts. This intermediate gear may be meshed into any one of the six gears forming the cone on the spindle, its position being controlled by the guiding handle fitted with a spring latch, this device engaging in the guiding slots and locking holes in the upper wall of the opening, as shown in Fig. 1. Six progressive direct spindle speeds are thus available, and as the machine is double back geared, a series of eighteen different progressive spindle speeds is supplied, having a range of 16 to 370 R. P. M.

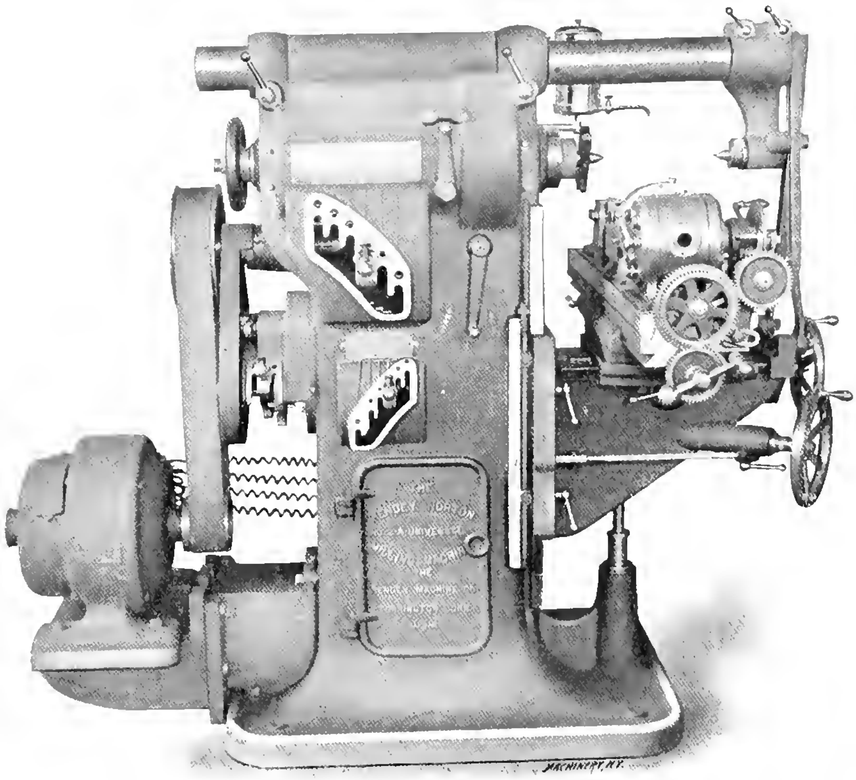


Fig. 1. Hendey-Norton, Geared Speed Miller, Left Side.

The back gearing may be constantly in mesh, if preferred, or it may be thrown out by means of the eccentric sleeve and lever, shown on the end of the back gear shaft in Fig. 2. When left in mesh it facilitates handling the entire range of speeds, as by means of the two positive clutches, one of which is mounted direct on the spindle and the other on the back gear shaft, one direct and two back gear speeds are handled for every setting made in the gear cone on the spindle. These clutches are controlled by the two levers shown on the left side of the machine, Fig. 1. All gearing of the above described combination, except the large face gear and large back gear, is made of steel. The clutches are of crucible steel and are hardened. The upper lever, shown in Fig. 1, controls the out and in clutch for giving either back gear or direct drive, while the lower lever controls the fast and slow back gear combination. The hand wheel attached to the rear end of the spindle furnishes a convenient means for rolling the spindle over by hand, either for entering gears or for setting a cutter close to the work.

The feed shaft is geared from the driving spindle with a chain and sprocket, as shown in Fig. 3, and the whole eighteen feed changes are available for each spindle speed. The feed index plate gives the table travel in inches running from ⅜-inch to 20 inches per minute. These speeds also practically apply to the saddle and knee as well as the table, as both are automatic. Any standard make of reversible motor may be used in place of a countershaft if desired, the method of mounting the motor being, as shown, very simple.

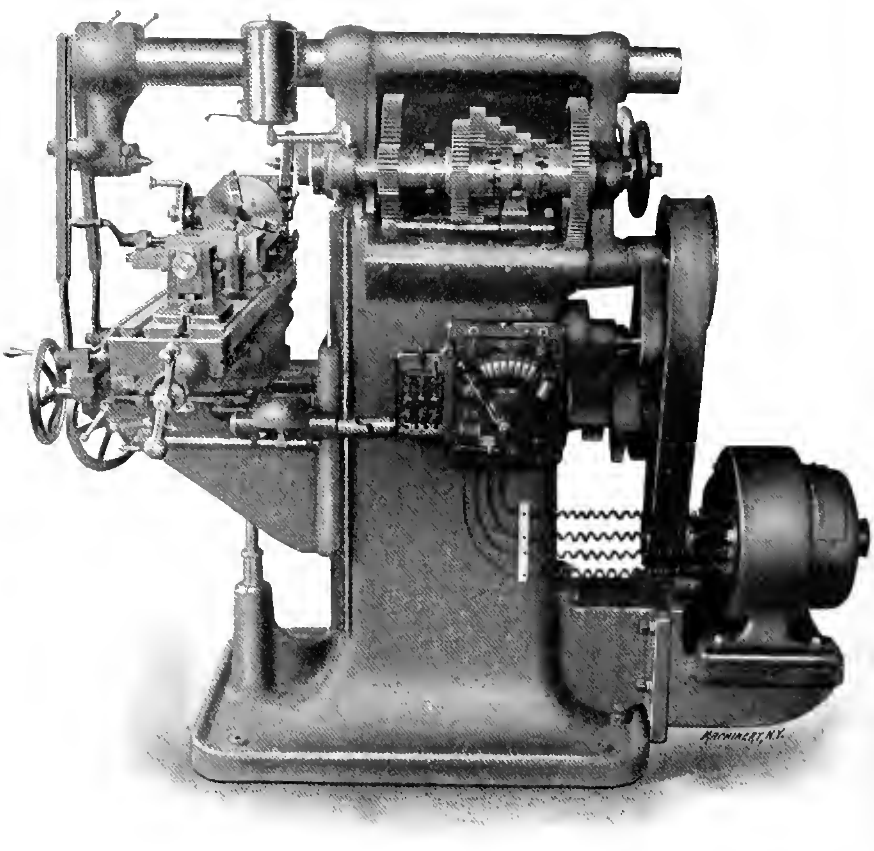


Fig. 2. Right Side of Machine, showing Gear Cone

A COLD SAW CUTTING-OFF MACHINE.

A newly designed and powerful cold saw cutting-off machine which has been recently shipped by the makers, the Espen-Lucas Machine Works, Philadelphia, Pa., to the Crocker-Wheeler Co , Ampere, N. J., is illustrated in the accompanying cut. This machine is similar in appearance to a bar cold

saw cutting off machine previously made by this company, but there is considerable difference in construction, the castings all being made heavier, steel replacing many iron castings. The drive is by a Crocker-Wheeler motor through a hammered crucible steel worm and phosphor bronze worm wheel and crucible steel gearing. The machine has a variable automatic feed, and automatic safety stop which throws out

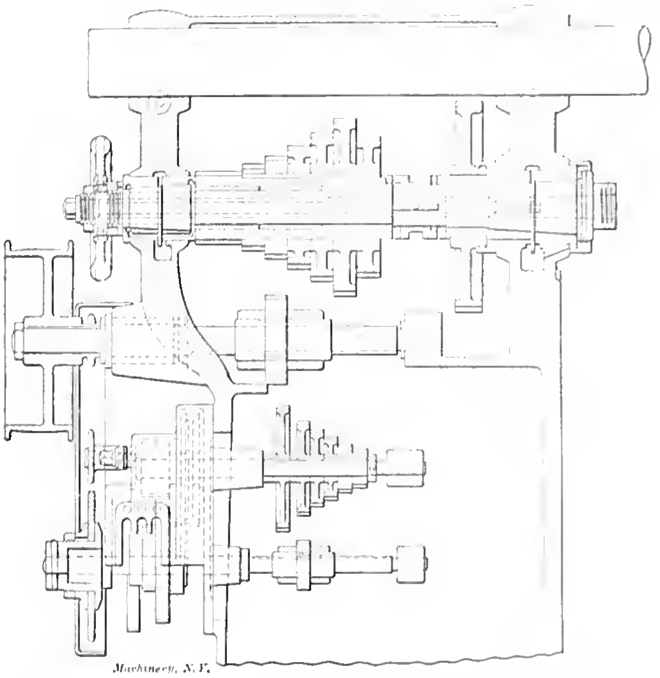
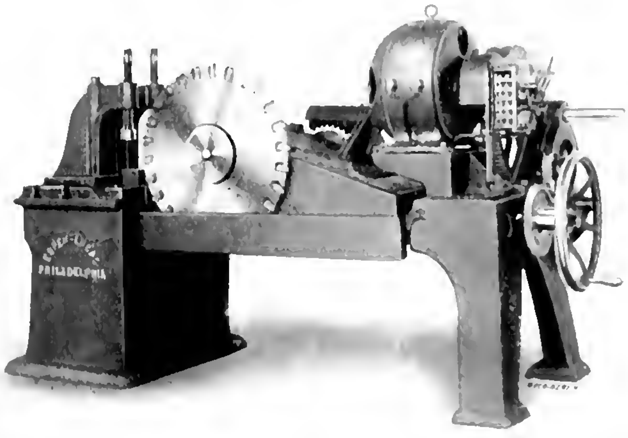


Fig. 3. Section through Speed and Feed Works. Geared Speed Miller

the feed at any depth of cut. The clamps are swiveled and can be placed upon any part of the platen for cutting material either straight or at an angle, or they can be entirely removed for cutting parts of large odd shaped castings. This machine is capable of driving the high speed inserted tooth saw blade shown in cut to its greatest capacity. This machine has cut 6-inch steel bars of 25 point carbon in 6 minutes, and good results have been



Cold Saw Cutting-off Machine.

shown in cutting high carbon steel. In actual use, this machine has cut 175 pieces of $7\frac{1}{2}$-inch 25-point carbon steel without regrinding the saw. These machines are furnished for belt or direct motor drive, and can, with slight changes, be arranged to saw rails, steel castings, forgings, etc., as well as bars.

DIAMOND POINT TOOL HOLDER.

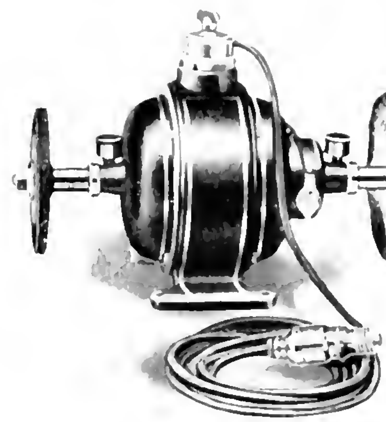
The Elgin diamond point tool holder, illustrated herewith, is the result of several years of experimenting on the part of the makers, The Elgin Tool Works, of Elgin, Ill. The cutter is made of square bars of self-hardening steel, and is held at the correct cutting angle in the holder for sharpening. The cutter needs only to be ground on the top, so that the diamond shape is thereby preserved for a much longer time than otherwise. The holder is made of tool steel and is planed flat on top and bottom. The cutter is held by an eccentric stud, no screws being used. The groove for the cutter is milled in the holder by gages.

Diamond Point Tool Holder

The holder is tempered all over and all parts are interchangeable. The tool can take a cut the full width of the cutter, and can be used on either lathe or planer. The holder is made in two sizes, No. 1 being 1 inch by $\frac{1}{2}$ inch, and the No. 2 holder $1\frac{1}{4}$ inch by $\frac{5}{8}$ inch.

GRINDING AND BUFFING MOTORS

The Lamb Electric Co., Grand Rapids, Mich., have put on the market a portable electrically driven grinder with emery and buffing wheels. We illustrate the quarter H. P. size of this apparatus. These motors are well balanced, insuring smooth running; shafts and bearings are extra large and long and the



Lamb Electrically-driven Grinder

commutators are of well insulated copper. They are particularly designed for large torque or pulling power. The armature is of the slotted type, and the field magnets are steel castings of high permeability.

MISCELLANEOUS TOOLS AND APPLIANCES.

A screw plate recently brought out by the Conant & Donelson Co., Greenfield, Mass., has as its chief feature the reversibility of the die blocks, so that it may be used for either machine or hand work. The screw plate is made in sizes from 3-16 to $1\frac{1}{2}$ inches.

The Reed Tool Co., Erie, Pa., are making a machinist's vise which may be swiveled in any direction, horizontal or vertical. Both horizontal and vertical swivels are provided with lock pins, but the friction clamps are sufficiently powerful to resist any ordinary force, the pins being merely to hold the vise in a fixed position.

A new machine for rapidly centering round stock is made by The Automatic Machine Co., Greenfield, Mass. The essential parts of the machine are a V-rest, adjustable to the diameter of the work, a bell-shaped center in the revolving spindle and a drill and countersink in the tail stock. Longitudinal slots divide the center into several prongs to give it a gripping action on the work when the latter is pressed into it.

A cutting-off machine for heavy work, embodying some new features of design, has been placed on the market by Nutter, Barnes & Co., Boston, Mass. The drive is of sufficient power for a 25-inch saw, 3-16 inch thick, cutting through metal of the maximum thickness allowed by a saw of this diameter. There are five changes of feed ranging from 1-5 to 1-2 inch per minute, and the carriage has a quick-return obtained by a clutch mechanism.

A quick-acting monkey wrench has been brought out by the Richards Tool Co., Boston, Mass. The quick motion of the jaw is obtained by rotating the handle of the wrench, which has an inner sleeve on which is cut a coarse-pitch helical groove. A projection extending down from the sliding jaw of the wrench fits in this groove and two or three turns of the handle cause the jaw to traverse through its whole range. A locking collar at the end of the handle, having small teeth fitting into corresponding teeth on the end of the sleeve, prevents the handle from turning, after the wrench is once set for a given size nut.

Furnaces for hardening, tempering and annealing for use with coal as fuel, where oil and gas fuels are not easily obtained, have been put on the market by the Kenworthy Engineering and Construction Co., Waterbury, Conn. The work is protected from the direct action of the flames by a grooved, tiled floor, the gas entering the heating chambers at the rear and passing out near the front. When the work is of such a nature that all contact with the flames must be prevented, a muffle is used for the protection of the work. The furnace is adapted for machine shops and other places where excessive radiation of heat would be undesirable, since the walls are well insulated. The furnace is built in three sizes.

* * *

FRESH FROM THE PRESS.

SUCTION GAS. By Oswald H. Haenssgen. Published by the Gas Engine Publishing Company, Cincinnati, O. 88 12mo. pages. Price, $1.00.

This is a monograph explaining the properties of suction gas, and the construction and operation of suction-gas producers, with practical information upon their use. It is a very brief treatise and one of the first to appear on this recent development of engineering.

ALTERNATING CURRENTS, THEIR GENERATION, DISTRIBUTION AND UTILIZATION. By Geo. T. Hanchett. Published by John Wiley & Sons, New York. 175 12mo pages, illustrated. Price, $1.00.

There are to-day many practical engineers who have an inadequate idea of alternating currents and alternating-current machinery. Mr. Hanchett's volume is a very elementary tratise, free from mathematics, and designed to explain the basic principles of alternating currents in a way that may be understood by all. Readers who have had difficulty in grasping this branch of electrical engineering, through the perusal of textbooks now available, will find in this one just the help needed to give them an intelligent start and prepare them for the more advanced works, if they have sufficient knowledge of mathematics to master the latter.

THE LAY-OUT OF CORLISS VALVE GEARS. By Sanford A. Moss. Published by the D. Van Nostrand Co., 23 Murray Street, New York, as one of their science series. 108 pages, illustrated. Price, 50 cents.

The matter contained in this handbook first appeared in *Power* and *The American Machinist*, and was written to supply an adequate treatment of the design of Corliss valve gears which, strangely enough, has not been thoroughly covered in the standard textbooks upon valve gears. This little work of Mr. Moss' will be appreciated by draftsmen engaged in steam engine work.

STEAM AND STEAM ENGINES, INCLUDING TURBINES AND BOILERS. By Prof. Andrew Jamieson. Published in America by the J. B. Lippincott Co., Philadelphia. 780 12mo. pages, illustrated. Price, $3.00.

This is the 14th edition of Prof. Jamieson's well-known and popular work upon the steam engine, and in this edition he has added a brief chapter upon the turbine, setting forth some of the elementary principles of this type of engine. There have also been additions to several of the old chapters, others been rewritten, while the whole book has been recast, repaged, and a new index prepared. Some of the changes consist in additional matter upon pyrometers and calorimeters, superheated steam and Corliss engines. A feature of the book is the questions and answers at the end of each chapter taken from various examination papers, and these have been added to in the new edition.

NOTES ON HEAT AND STEAM. By Prof. Chas. H. Benjamin, Case School of Applied Science, Cleveland, O. Published by Chas. H. Holmes, 2303 Euclid Avenue, Cleveland, O. 93 12mo. pages, illustrated. Price, $1.25.

A new and revised edition of Prof. Benjamin's little treatise on thermodynamics, which has been favorably known as a convenient handbook for engineers and draftsmen for several years past. Many, who have felt compelled to consult elaborate works on this subect, have done so under protest and with the desire that something in the way of a condensed handbook were available. This work will be found to meet the situation exactly. It contains all the thermodynamic formulas that the practical engineer will be likely to need for his calculations upon heat and steam, together with some other matter not usually included in textbooks upon thermodynamics, such as data upon combustion and fuel, and information upon chimneys and their design. The new edition has a chapter upon air, gas and refrigeration cycles not in the earlier editions, and the other chapters have been added to and revised as needed.

MARINE ENGINES AND BOILERS, THEIR DESIGN AND CONSTRUCTION. By Dr. G. Bauer, Engineer-in-Chief of the Vulcan Works, Stettin. Translated from the German by E. M. and S. Bryan Donkin, and edited by Leslie S. Robinson. An English work, published in New York by the Norman W. Henley Publishing Co., 132 Nassau Street. 744 8vo. pages, illustrated. Price, $9.00.

This work was prepared by Dr. Bauer to supply the needs of young engineers, and he has succeeded in combining in condensed form both a great deal of practical information upon marine engineering and enough of theory to make the work valuable to the designing engineer. Dr. Bauer's unusual opportunity for securing practical data and drawings, and his extended experience as a marine designer, well qualified him for the work, and the book has been much appreciated in Germany and has had an extensive sale in that country. The translation into the English language has been made by well-known English engineers, and tables and mathematical work have been converted from metric units into English units. While there are several excellent works by English engineers which cover about the same field as this one, such as Seaton's Manual, students of marine engineering and engineers engaged in marine work will be glad of an authoritative volume embodying information about German practice. The rapid progress in Germany in the line of ship building and marine machinery during the past few years makes this German treatise all the more timely.

The book is divided into eight parts as follows: First, The Marine Engine, under which are treated cylinder dimensions and the utilization of steam; the arrangement of the engines, and engine details. Second, Pumps. Third, Shafting; The Resistance of Ships and Propellers. Fourth, Pipes and Connections, including flanges, valves, under-water fittings, steam and exhaust piping, feed water pipes, bilge pipes, circulating pipes, etc. Fifth, Steam Boilers, including descriptions of the different pipes and practical information upon firing and the generation of steam, forced draft, boiler fittings, etc. Sixth, Measuring Instruments. Seventh, Various Details. Eighth, Various Tables.

The book is handsomely bound and printed, is illustrated by a great many drawings and folding diagrams, and in selecting samples of marine practice from which the illustrations were made only the most modern types of marine engines and boilers have been taken.

TOOLS FOR ENGINEERS AND WOODWORKERS. By Joseph Horner. 340 pages $5\frac{1}{4}$ x 8 inches, and 456 illustrations. Published by Crosby, Lockwood & Son, London. Price, $3.50.

This work is by a well-known author who for many years has contributed articles of much technical merit to English and American trade papers, and who is the author of "Pattern Making," "Hoisting Machinery," etc. The book under review consists in a large part of selections from various articles contributed to the *English Mechanic* and the *Mechanical World*. The grouping together of matter upon iron working and woodworking seems ill-advised from the American point of view as the two trades are widely separated in this country, but such apparently is not the case in English practice. In the introductory chapter the author gives the distinction between a tool and a machine and briefly defines tools in general. Chapter I takes up the important subject of cutting angles and in it the author calls attention to the lack of uniformity, especially in metal working tools, and to the desirability of securing a more general agreement in shop practice. For instance, he says that there is little reason why the angle of clearance of metal cutting tools should ever exceed 5 or 6 degrees, but it often does without any apparent detriment to the permanence of the cutting edge. Under the head of The Chisel Group, Section 1, are five chapters: Chisels and allied Forms for Woodworkers; Planes; Hand Chisels and Allied Forms for Metal-Working; Chisel-like Tools for Cutting Metal by Planing, Etc.; The Shearing Action and Shearing Tools. Without further outlining the scope of the various chapters, we will refer to specific chapters such as that on saws, which seems to be of considerable value; milling cutters; boring tools for metal; hardening and tempering; standards of measurement; measuring tools; etc. In the review of a work of this character, of which a number have been brought out within the past year or two, one cannot help being struck with the fact that American small tools are about the only ones that seem to be considered worth describing. It would be very interesting to know to what extent the world is indebted to the American manufacturer of small tools for the development of the art, and to what extent he has drawn upon the tools and devices of European workmen for his models. In other words, whether the universal use of American small tools is altogether due to their excellence or whether it is due to the fact that America is about the only country in which small tools are manufactured and sold at prices that put them within the reach of the ordinary mechanic. The work is one that trade schools may be able to use profitably, but it contains little practical data for the journeyman. It reviews well-known tools and elementary principles, and the apprentice can doubtless read the book with considerable profit.

WEBSTER'S INTERNATIONAL DICTIONARY.—New edition containing 25,000 new words, and 5,000 illustrations. Published by the G. & C. Merriam Co., Springfield, Mass. Price, bound in sheep with marble edge, $10; with complete reference index, notched on edge, $10.75. Other bindings at various prices up to $18 for Turkey morocco with gilt edge.

Webster's Dictionary, beginning with the 1847 edition by Noah Webster, has had a long and honorable career (if a great work like this can be said to have a career) in the United States, and thousands of educated men and women think of it as the *only* authoritative reference for definition, derivation and pronunciation of the English language. The "International" edition is the successor of the once popular "Unabridged," being a thorough and complete revision of that work. The latest edition of the "International," recently issued, has 2,380 pages and includes 25,000 new words and phrases in a supplement. The pronouncing biographical dictionary and the pronouncing gazetteer or geographical dictionary of the world supplements have also been revised; the latter embraces the most recent statistics available. In short, the new edition may be truthfully said to comprise not only a defining and pronouncing dictionary but also a very comprehensive cyclopedia of information which scarcely any man can afford to be without.

NEW TRADE LITERATURE.

THE CROCKER-WHEELER CO., Ampere, N. J. A reminder of the warm weather that is to come is a pamphlet issued by this company describing motor-driven fans.

PETER A. FRASSE & CO., 92-94 Fulton St., New York. Price list of Boldi tool steel giving sizes and prices of steel and containing suggestions for the proper treatment of steel.

COLBURN MACHINE TOOL CO., Franklin, Pa. Illustrated circular of the new 30-inch vertical boring and turning mill made by this company, a description of which has recently appeared in MACHINERY.

DETROIT TWIST DRILL CO., Detroit, Mich. Catalogue of Graham twist drills and chucks, the former having grooved shanks to fit the jaws of the chuck. Also twist drills are listed of standard styles.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Illustrated pamphlet upon machine tool drives showing the application of motors to machine tools of different types and containing descriptive matter and tables upon the subject of motor driving.

P. BLAISDELL & CO., Worcester, Mass. Illustrated catalogue of engine lathes in sizes from 13-inch to 30-inch swing; of patternmakers' lathes in several sizes and of upright drill presses from 20-inch swing to 50-inch swing. The catalogue is handsomely illustrated.

FAY & SCOTT, Dexter, Me. Catalogue of patternmakers' lathes which are made in a full line of sizes from a 90-inch faceplate lathe containing new features to a 10-inch lathe for manual training schools. There is also a 36-60-inch extension gap lathe illustrated.

"Air Power" is the title of a new quarterly issued by the Rand Drill Co., of New York. It is an attractive 24-page publication, primarily in the interests of the Rand Drill Co., and containing an abundance of readable and valuable material, fully illustrated, upon subjects pertaining to compressed air and its use.

WILMARTH & MORMAN CO., Grand Rapids, Mich. The "New Yankee" Drill Grinder and Other Tools. Catalogue No. 90. This describes and illustrates the company's "New Yankee" Drill Grinder, Friction Countershafts, Arbor Presses, and the "Nelson Loose" Pulley. A description of the various styles is given.

THE DERRY-COLLARD CO., 256 Broadway, New York, have started a "Book News Service" consisting of pamphlets issued from time to

MACHINERY.

July, 1905.

VARIABLE SPEED MECHANISMS.—3.

CONE AND DISK DEVICES. (Continued.)

A device for transmitting motion was patented Dec. 6, 1887, No. 374,296, by G. Frank Evans, which was an improvement on the Laird patent No. 299,231. (Fig. 20, June issue, page 510.) The object of Mr. Evans' invention was "to provide a variable speed mechanism which might be applied to wood-working machines, or metal-working machines, or any machine that receives power through belting." The principal

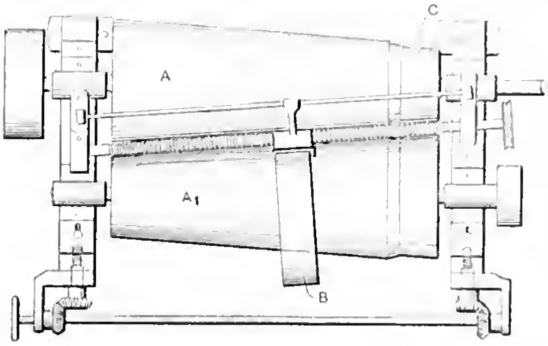


Fig. 22. Patent No. 374,296, Granted G. Frank Evans, 1887

feature of novelty of the Evans invention appears to be the annular recesses at the right end of the cones A A_1 (Fig. 22) into which the endless belt B can be shifted so that motion may be stopped. In other words, the Evans invention provides means by which motion can be started and stopped by the same means which permits the speed ratio to be varied. He also provided a convenient means for varying the distance between the two cones; this device consisted broadly of two screws for moving the boxes of one cone, which were arranged so as to move in unison, being connected by a longitudinal shaft and bevel gears.

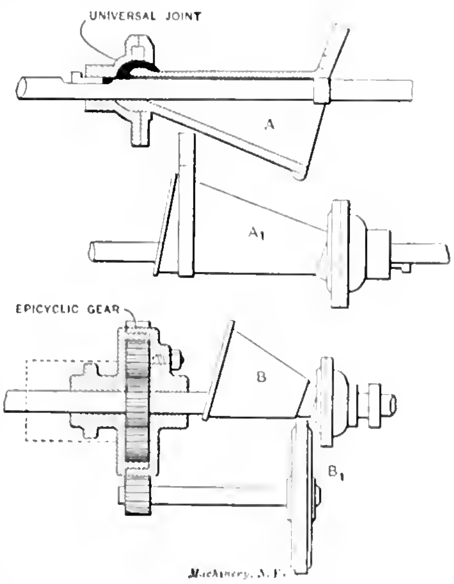


Fig. 23. No. 377,598, Issued to W. W. Beaumont, 1888

Fig. 23 is part of one of the drawings illustrating the scope of patent No. 377,598, issued to W. W. Beaumont, February 7, 1888. The Beaumont device consists essentially of a hollow cone mounted on a shaft, with a universal joint at the small end so that the working side of the cone, or the side in contact with the belt, may lie parallel to the shaft axis. Since the cone moves at the same angular velocity as the shaft, it follows that all parts of the cone surface must move at the same angular velocity; and this means, of course, that the belt surface at the large end travels at a higher peripheral rate of speed than at the small end, although it apparently lies at the same radial distance from the shaft axis. When two of the Beaumont cones are to be used for variable speed transmission by means of belts, they are, of course, placed with the large end of one opposite the small end of the other as shown at A and A_1. The advantage claimed for this combination is, that the belt runs upon them very much as it does upon two cylindrical drums or pulleys. This contention, however, is not well grounded, for the climbing action of the

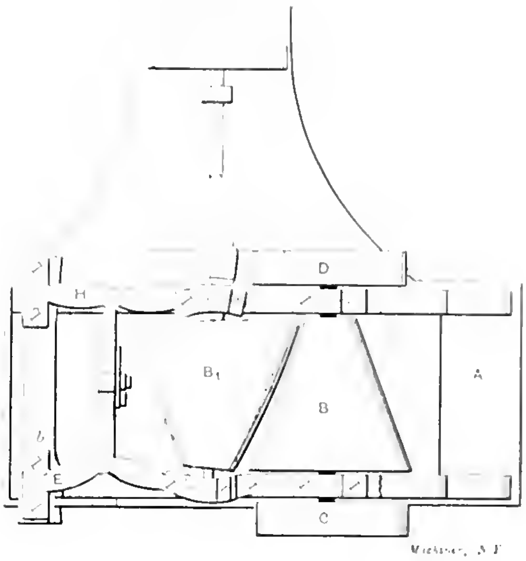


Fig. 24. No. 10,968, Granted to M. Hoffman, 1888

belt upon the cones will be the same as though the cones were solidly mounted upon parallel shafts. The reason for this is, that the belt, as it first winds upon the cone, comes into contact with a surface that is nearer the base of the cone than that which it should properly occupy when it reaches the plane of the two shafts. The result is that there must be a continual tendency for the belt to shift to the large ends of the cones. The lower view in Fig. 23 shows one cone mounted on

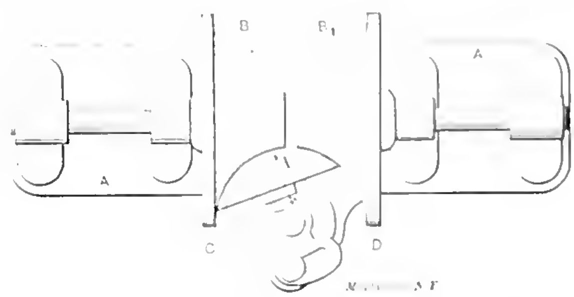


Fig. 25. Patent No. 457,100, Granted to C. C. Yates, 1891

a shaft with an epicycloidal gear train, the outer gear of which is engaged with the pinion on the friction wheel shaft. The cone is movable longitudinally on its shaft so as to permit different cone diameters to be placed in contact with the friction wheel, and thus vary the rate of transmission.

Fig. 24 (patent No. 10,968, granted to M. Hoffman, November 27, 1888) embodies practically the same principle as that illustrated in Fig. 14 (June issue) with the difference that in the Reiss patent the rotating members are disk shaped, while, in the Hoffman invention, they are more distinctly cone-shaped. One cone B, is made with straight sides and cone B_1 is made with the sides curved so that only a short portion of its length can be in contact with cone B. This device which was intended as a feed-changing mechanism for the carriages

of saw mills, is provided with two toggle-joints, H and E, by which the boxes carrying the shaft of cone B_1 are shifted so that different portions of the two cones are brought into contact, thus varying the feed rate. This rather ingenious combination of toggle-joints enables a heavy pressure to be easily brought to bear on that portion of the cone which is in contact with cone B, and at the same time gives the swinging action necessary to bring different portions of cone B_1 into contact with cone B.

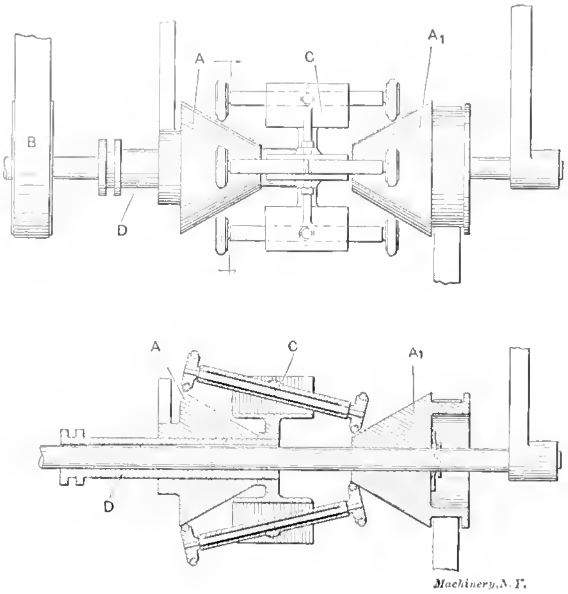


Fig. 26. No. 464,895, Issued to John Riddell, 1891.

Patent No. 457,100 was granted to Calvin C. Yates, August 4, 1891, for an improvement in frictional gearing. The device, as shown in Fig. 25, consists essentially of two shafts carrying hubs B B_1 on opposing ends, which are so shaped that a longitudinal section shows arcs of a circle, and the relative position of the two hubs is such that one arc is the continuation of the other, thus forming a partial torus in which the frictional member C may be shifted on the pivot D and still remain in frictional engagement with both B and B_1. The principle is very similar to the Hunt patent. (Fig. 18, June issue.)

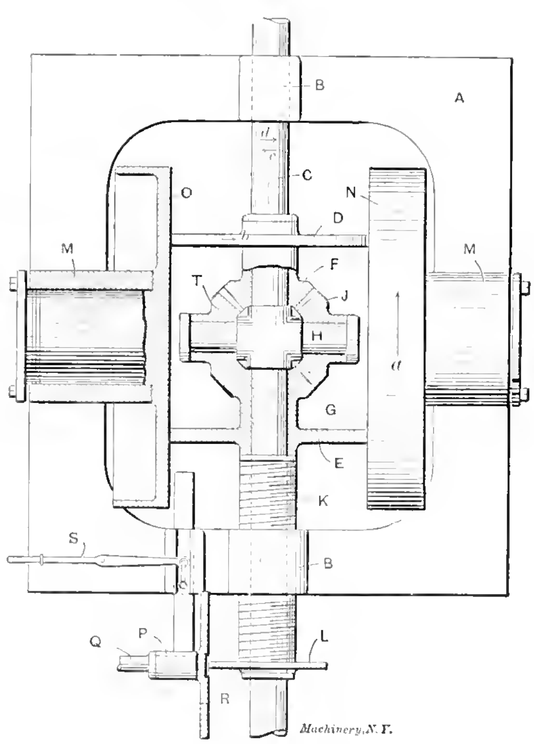


Fig. 27. No. 467,593, F. W. Gordon, 1892.

John Riddell was granted patent No. 464,895, December 8, 1891, for the variable transmitting mechanism shown in Fig. 26. This device consists essentially of two opposing cones, A and A_1, having coincident axes, one cone being, of course, the driving and the other the driven member. Motion is transmitted from one cone to the other by a series of friction rollers C, arranged in a circle. These rollers are connected by shafts and are provided with pivotal bearings in the center so that they are free to swing to whatever angular position is required by the position of the sleeve D. Moving D longitudinally changes the relative positions of the friction rollers upon the cones, and this, of course, changes the relative rate of transmission.

Patent No. 467,593, granted to F. W. Gordon, January 26, 1892, is described in an interesting specification and is illustrated in Fig. 27. D and E, referred to as brush wheels, are mounted loosely on shaft C and have projecting hubs which terminate in the bevel gears, F and G. Between these gears are other bevel gears, T and J, mounted on studs projected at right angles from the shaft, thus forming the familiar "jack-

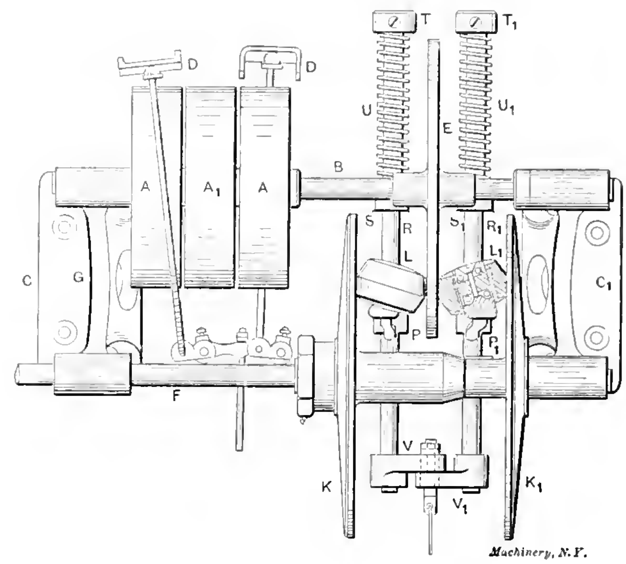


Fig. 28. No 568,367, E. C. Osgood, 1896.

in-the-box." Brush wheels D and E are held in frictional contact with the disks N and O. The mechanism shown below is for varying the position of the brush wheels upon the disks. Quoting from the specification, "Assume that disk N is driven, as by belt, at high speed in the direction of the arrow, a, at a regular rate of speed. Assume that the brush-wheels, D and E, are equidistant from the center of the disk, as they appear in the drawing. The disk will drive brush-wheel D in the direction of the arrow, b, and will drive brush-wheel E in the opposite direction, both brush-wheels revolving at the same speed. Gear F turns with brush-wheel D and rotates the plan-

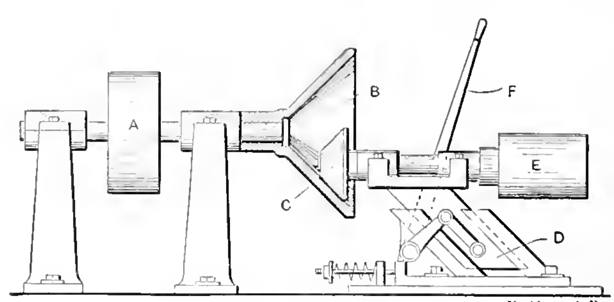


Fig. 29. No. 599,193, E. R. Plaisted, 1898.

etary gear, J, upon its stationary stud, H. Gear G forms no impediment to the rotation of the planetary gear, because gear G is turning in the same direction and at the same rate of speed as it would if driven by the rotation of the planetary gear instead of through the brush-wheel E. The result is that the shaft stands still and the planetary gear turns idly on its stud. If now we move the shaft endwise a trifle toward the upper portion of the drawings, we still have the two brush-wheels D and E turning in opposite directions, as before; but the two brush-wheels no longer engage the disk equidistantly from its center, and therefore the two brush-wheels will not turn at their former rates of speed, nor will they both turn at the same rate of speed. Brush-wheel D will turn faster than it did before and brush-wheel E will turn slower than it did before. Gear F still seeks to turn the planetary gear

idly on its stud; but gear G is not turning fast enough to allow the planetary gear to rotate freely, as in the former case. If the shaft could not turn, a deadlock would occur at the planetary gear; but the shaft is free to turn in the direction in which brush-wheel D turns (arrow b) and permit the planet-stud and planet-gear to take up a motion of planetary advance around the shaft. The rate of this planetary advance will be

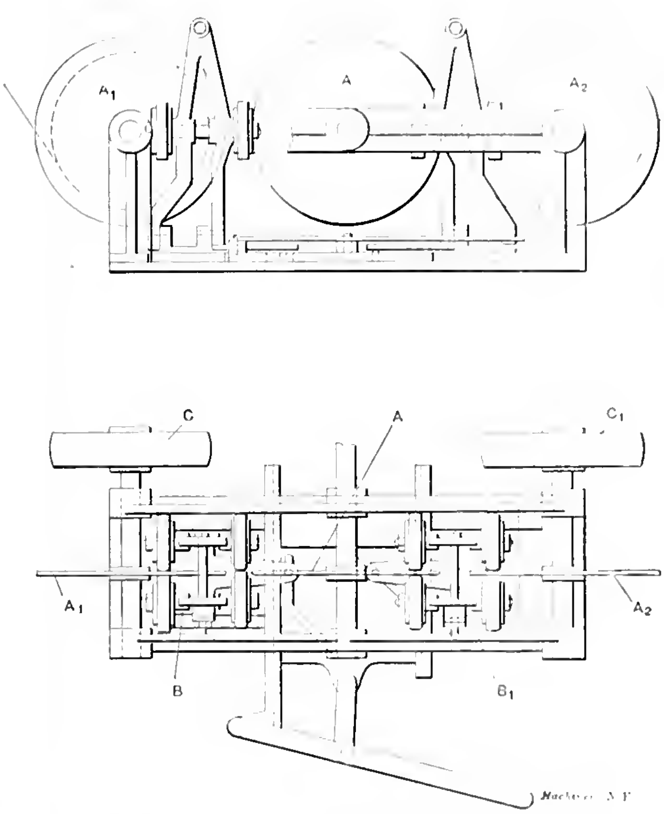


Fig. 30. No. 650,815, Granted to James Arthur, 1900

governed by the difference in velocities between gears F and G. In other words, if the two brush-wheels D and E do not turn at the same velocity, the planet gear is forced into planetary motion, and consequently the shaft C is rotated in the direction of rotation of the fast-moving brush-wheel. The two brush-wheels may be so adjusted that their rates of rotation differ to an infinitely small degree, and the result will

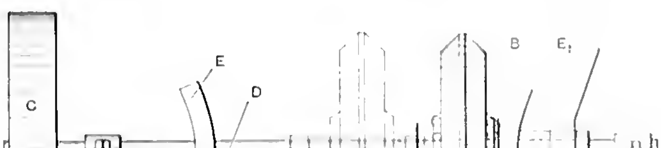


Fig. 31. No. 637,202, J. C. Des Granges, 1899

be that the shaft is turned at an infinitely slow rate of speed. The rate of speed of the shaft may be altered by adjusting the position of the brush-wheels with reference to the disk which drives them, and the direction of motion of the shaft is also under control, the shaft moving in the direction of rotation of the faster-turning brush-wheel. The device therefore provides for an infinitely great reduction of speed, for a control of the direction of transmission, for the most delicate graduations of reduction, *and for powerful transmissions.*

It is scarcely necessary to point out the mistake of the inventor in assuming that this device can be employed for a powerful transmission. In other words, the change in velocity ratio is not accompanied by the corresponding change in the leverage. The actual torque of shaft C must always depend upon the friction coefficient of brush-wheels D and E; hence, it is obvious that the device is not suitable for "powerful transmissions."

In the mechanism for transmitting motion by variable speed, patented by E. C. Osgood, September 29, 1896, No. 568,367, (Fig. 28), the inventor claims a great range of speeds and exceed-

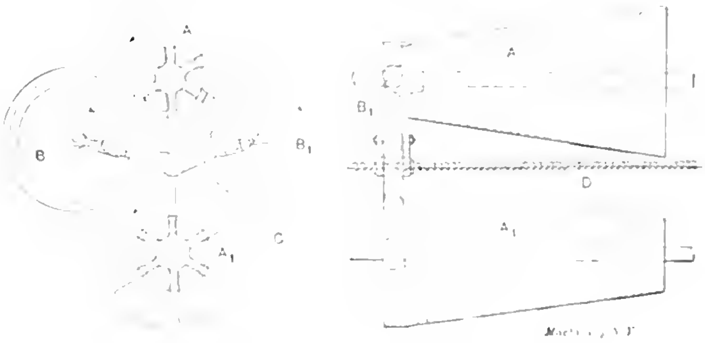


Fig. 32. No. 675,133, A. Janssens, 1901

ingly exact adjustment, with slight friction and with great economy. It comprises a shaft B on which is mounted the disk wheel E; and the two disk wheels K and K_1, arranged on opposite sides of E and embracing between them the rollers L and L_1. These rollers are mounted on ball-bearings and are of double cone shape to minimize as far as possible the difference in speed of the actual surfaces in contact, from which it follows that the friction rollers are tipped so that the planes of rotation are at angles other than right angles with the plane of rotation of the disk wheels.

In the invention shown in Fig. 29, which was granted to E. R. Plaisted, February 15, 1898, No. 599,193, the hollow cone B is employed to drive friction cone roller C. The cut shows the means employed for varying the relative position of C and B, and thus varying the velocities of pulleys A and E. One interesting feature of this invention is, that when C is brought to the center of cone B, the two run at the same rate, the action in this position being essentially the same as that of a cone clutch.

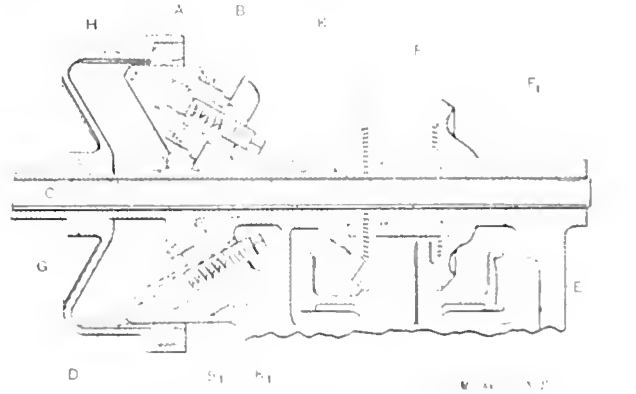


Fig. 33. Patent No. 675,060, O. Norling, 1901

Fig. 30 illustrates the invention of James Arthur, patented June 5, 1900, No. 650,815, which was designed for transmitting considerable power. It also provides means by which the driven disk A may be reversed at will. When made with the reversible feature, the power is transmitted through pulleys C and C_1 which drive disks A_1 and A_2 respectively. The nests of friction rollers, B and B_1 are mounted on slides, and connecting these slides is a slotted plate which is given a transverse motion by a hand lever. The slots in this plate are so shaped that one slide remains stationary during the movement of the other slide in or out with its rollers in engagement with its respective disks. Suppose that the slide is being operated so that the nest of friction rollers B_1 is being moved to the right, the left-hand slide remains station-

ary until friction rollers B_1 have moved out of engagement with disk A and then the movement of the slide carrying the friction rollers B begins and effects the reversal of A.

Of a far less practical nature is the invention, Fig. 31, patented by J. C. Des Granges, November 14, 1899, No. 637,202, as a motion-reversing and speed-changing mechanism. Means are provided for shifting cone A longitudinally upon the shaft F, and simultaneously shifting the double cone B on shaft D so as to maintain frictional contact between the conical sur-

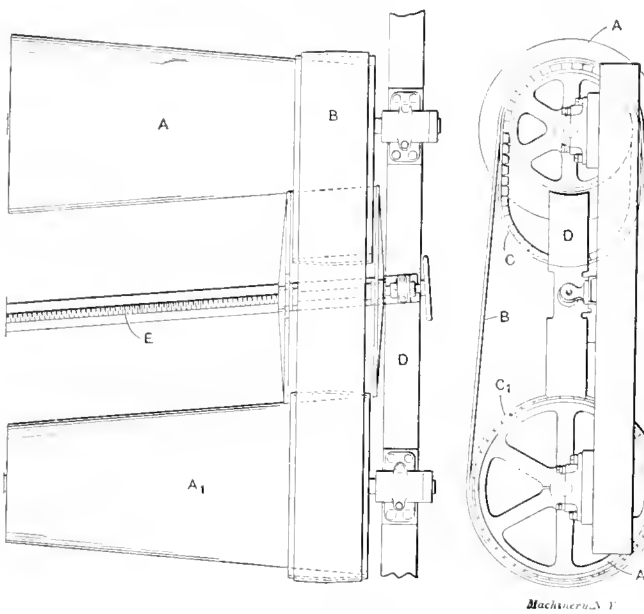


Fig 34. No. 703,359, J. A. White, 1902.

faces. By continuing the motion of B beyond the center, it is evident that reversal of motion would be obtained and that the curved arms would in theory sustain B in contact with A in the reversed position.

The variable speed transmitting gear shown in Fig. 32 was patented May 28, 1901, No. 675,133, by A. Janssens. It comprises two cones A A_1, mounted on parallel shafts in such a manner that the apex so called, of one cone corresponds with the base of the other, and connected by the friction rollers B

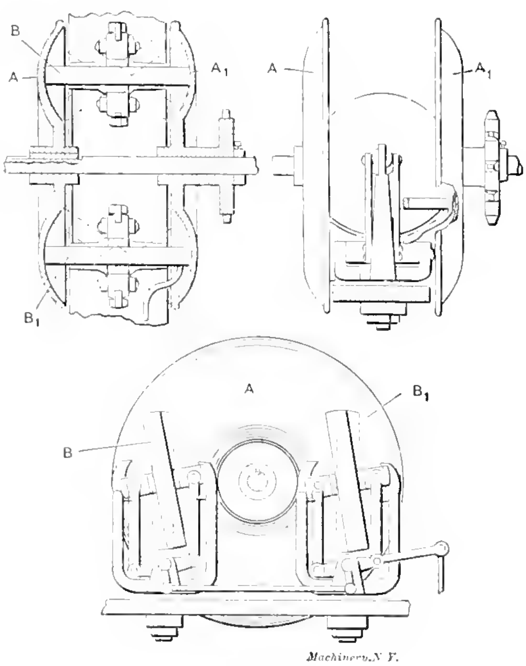


Fig. 35. No. 703,237, E. P. Cowles, 1902.

and B_1. These friction rollers are connected by a jointed frame C and are given a longitudinal motion by means of screw D. The inventor states that his object is "to remedy certain defects of the transmitting gear heretofore encountered, by permitting the use of rollers of convenient diameter, corresponding to the power to be transmitted by the mechanism. At the same time, the invention enables the constructor to double the number of points of contact without difficulty and to balance as completely as possible the strain acting on the principal parts of the transmitting device."

The invention illustrated in Fig. 33 shows one drawing illustrating the specification of patent No. 675,669, issued to O. Norling, June 4, 1901. This speed change gear was designed more particularly for use in driving the feed mechanism of automatic metal working machines; hence the peculiar disposition of the parts as shown in the cut. The clutch mechanism shown between the bevel gears F and F_1 is evidently for the purpose of reversing shaft C, and it does not affect the function of the variable speed device. The hollow friction wheel, A, which is mounted on a sleeve G, is splined thereon so that it may be moved longitudinally to vary the speed motion. Within a hollow wheel are mounted the adjustable friction cone rollers B and B_1, which have bevel gears fixed to their bases. These gears mesh with the central gear H, which is part of a sleeve, on which is mounted the bevel gear F; hence it is plain that the rate of motion transmitted to sleeve G will depend upon the relative position of A upon it, since motion is communicated to G from the belt pulley E through bevel gear F, gear H, and friction rollers B and B_1. The pressure of the friction rollers on A is regulated by the adjusting screws and springs K K_1.

In the speed changing device shown in Fig. 34, which was patented by J. A. White, June 24, 1902, No. 703,359, the principal feature of interest is the provision made for the supporting of the driving belt upon the cones and compensating the effect of the taper. The inventor says that "Heretofore the

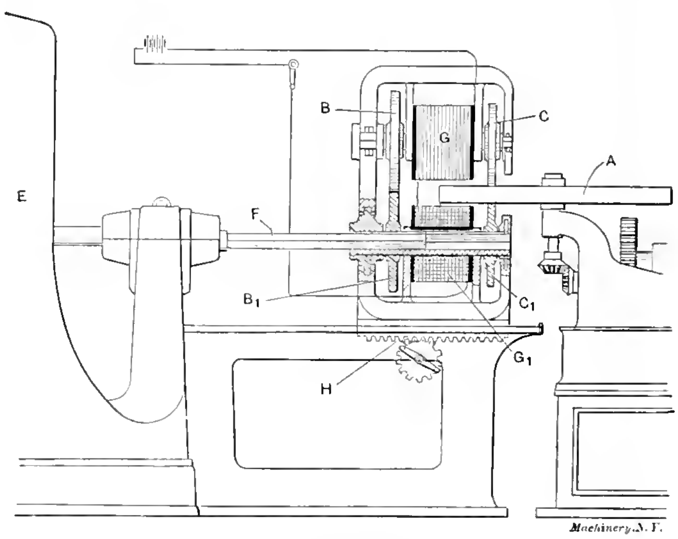


Fig. 36. No. 745,593, G. H. Gibson, 1903.

power which could be transmitted from a driving to a driven element through cone-pulleys was limited owing to the fact that a wide belt could not be used, the width of the belt being limited because of the taper of the pulley or pulleys." Hence he provides an inner band for each cone-pulley beveled on the inner face, according with the bevel of the cone pulleys, and possessing an inner face susceptible of longitudinal expansion and contraction, which is called a compensating band. The illustration shows the means employed for traversing the belt B from one end of the cone-pulleys to the other and also shows the compensating bands C C_1. In the case of C, which is at the small end of the cone, only a portion of its length is required to encircle the working periphery of the cone, but in the case of C_1, which is at the large end of the cone, the full length is required. The invention is, in effect, a combination cone-pulley and expanding pulley device.

Fig. 35 shows a variable speed friction gearing patented by E. P. Cowles, June 24, 1902, No. 703,237, which provides means for automatically shifting the position of the frictional rollers relative to the driving and driven elements in order to vary the speed. The inventor uses the word "automatically," but his meaning is that his invention provides means by which the position of the friction rollers may be shifted with a minimum exertion of the power on the part of the operator. He mounts the rollers B and B_1 between the disks A and A_1 so that they may be adjusted from their normal tangent posi-

tion to a position in which other planes of rotation will not be tangent to a circle concentric with the shaft. In this position they tend to shift at a rate according to the angle to which they are twisted by the operator, since their faces tend to travel in a spiral within the torus formed by the two disks A and A_1.

Patent No. 745,593 was granted December 1, 1903, to G. H. Gibson for a magneto frictional gearing. The driving shaft F from the motor E is splined and drives a sleeve, on which are mounted the rollers C_1 and B_1. Between these rollers is mounted a spool of wire G_1 and at B, G, and C is a similar arrangement. The coils G and G_1 form an electromagnet which, being energized, forces the rollers C and C_1 against the sides of the disk-wheel A; the energizing force also brings rollers B and B_1 into forcible contact, thus transmitting motion to C and making it a driver as well as C_1. The rack and pinion

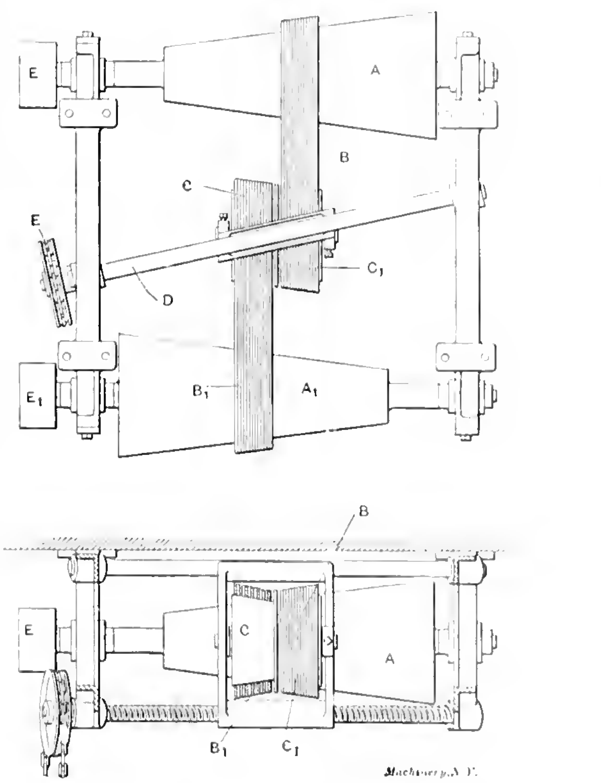


Fig. 37. No. 759,872, Wm. Evans and P. W. Knauf, 1904

provided for shifting the magnetic friction rollers in and out upon A for varying the speed are shown at H.

The variable speed transmission device illustrated in Fig 37 was patented May 17, 1904, No. 759,872, by William Evans and Paul W. Knauf. In this invention the cone-pulleys A and A_1 are not directly connected by one belt, but two belts are used which transmit motion from one to the other by means of a double cone-pulley $C\,C_1$. The object of this arrangement is to compensate for the taper of the cones so that all portions of the belts may travel at the proper speed and thus avoid the destructive action due to the cone and belt elements traveling at different rates of speed. The invention therefor is supposed to make it possible to use wide belts and thus transmit considerable power.

* * *

The *Journal* of the Worcester Polytechnic Institute abstracts an item from a French contemporary giving the efficiencies of various kinds of gears of the proportions used in automobile service, as follows: Spur gearing, steel on steel, greased, but exposed to street dust, 90 and 80 per cent; spur-gearing having steel pinion engaging with fiber gear-wheel, 88 and 80 per cent; spur-gearing having leather pinion engaging with a cast-iron gear-wheel, 88 and 80 per cent; spur-gearing, steel on steel, in oil bath, 92 and 90 per cent; roller chain, lubricated and exposed to the air, 94 and 92 per cent; and universal joint, 95 per cent. In the above cases the first set of figures for each gear represents the percentage of efficiency for new gearing, and the second set for worn gearing.

CALCULATIONS FOR THE SHAFT, GEAR AND BEARINGS OF CRANE MOTORS.

GFORGE J LEIRE

To illustrate definitely the use of the table and diagrams in the method of calculation about to be set forth the following example will be taken:

Given: A crane motor with 4 poles, 15 H. P., 750 R. P. M at normal load:

Diameter of armature	$= 9\frac{1}{2}$ inches
Air gap	$= 3/32$ inch
Area of pole face....................	$= 29$ square inches
Density in air gap, given in lines of force per square inch...........	$= 55,000$
Total weight of rotating part........	$= 150$ pounds

From a general layout drawing of the motor we have the dimensions given as in Fig. 1.

Motors for hoisting purposes are usually series wound, and thus run at different speeds under different loads. Therefore, if the motor is to be run with a certain over-

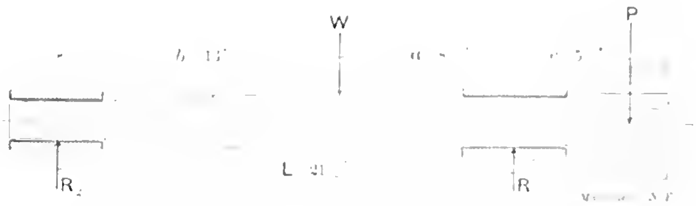


Fig 1 Dimensions of Shaft and Bearings, from General Layout

load, we have to take into consideration the corresponding speed and density in air gap, which can be obtained from the speed and excitation curves of the motor. In this example we suppose an overload of 25 per cent, and have accordingly:

18.75 H. P., 700 R. P. M and a density in air gap $= 58,800$ lines of force per square inch.

Calculating the Gear.

For figuring the gear we suppose a diametral pitch $= 5$ and number of teeth $= 18$.

This gives us a pitch diameter $= \dfrac{18}{5} = 3.6$ inches.

Thus the pitch line speed at

$$700 \text{ R. P. M} = \frac{\pi \times 3.6 \times 700}{12} = 660 \text{ feet per minute.}$$

It is not advisable to use a pitch-line speed exceeding 1,000 feet per minute, on account of noisy running.

Before figuring the width of gear we have to determine the pressure P on the teeth. This is given by the following formula:

$$P = \frac{\text{H. P.} \times 33{,}000}{\text{Pitch line speed}}$$

where P is expressed in pounds and pitch line speed in feet per minute. Thus for 18.75 H. P. and a pitch line speed of 660 feet per minute

$$P = \frac{18.75 \times 33{,}000}{660} = 910 \text{ pounds approximately.}$$

The width of gear is given by the formula:

$$w = \frac{P}{f \times C_1 \times C_2} \text{ where}$$

$w =$ width of tooth on gear in inches

$P =$ pressure on tooth in pounds.

$f =$ permissible fiber stress in thousands of pounds per square inch.

$C_1 =$ coefficient depending on diametral pitch and number of teeth on gear. Its values can be obtained from table given as Fig. 2.

$C_2 =$ coefficient depending on pitch line speed. Its values can be obtained from curve in Fig 3. If we suppose a gear of steel we may use a fiber stress of 8,500 pounds per square inch. We therefore get as the width of tooth:

$$w = \frac{910}{8.5 \times 52 \times .5} = 4\tfrac{1}{4} \text{ inches, approximately.}$$

Besides the weight of the rotating part and the pressure on the gear we must, when figuring the shaft and bearings, take

into consideration the unbalanced magnetic pull caused by a displacement of the armature of the motor in relation to the poles. If B is the density given in lines of force per square inch at air gap, A is the area of pole face in square inches, and k is a constant which

for 4-pole machines $= 2$
6-pole machines $= 4.7$
8-pole machines $= 7$

Then the magnetic pull per pole $= \dfrac{B^2 \times A}{k \times 72{,}134{,}000}$ pounds.

This formula gives us in our example a magnetic pull per pole $= \dfrac{58{,}800^2 \times 29}{2 \times 72{,}134{,}000} = 700$ pounds approximately. The pull per inch of the circumference of pole bore

$$= \frac{4 \times \text{pull per pole}}{\pi \times \text{pole bore}} = \frac{4 \times 700}{\pi \times 9.69} = 92 \text{ pounds approximately.}$$

If we now suppose a displacement of armature of 25 per cent of the normal air gap, the ratio between air gap and displacement $= 4$. In the diagram, Fig. 4, reading on vertical side the pull per inch of the circumference $= 92$, and on the horizontal side the ratio between air gap and displacement $= 4$. The curve 55 passing through the intersection point of 92 and 4 indicates that the half value of the maximum magnetic pull per inch of circumference of pole bore is:

$\dfrac{M\,max}{2} = 55$ pounds. Thus $M\,max = 55 \times 2 = 110$ pounds. In order to give the values of $\dfrac{M\,max}{2}$ as exactly as possible for a wide range of values of magnetic pull and displacement ratios, the diagram in Fig. 4 contains two sets of curves, one in the lower right corner on a small scale, and one in the upper left corner on a larger scale.

The total magnetic pull on armature

$$= \frac{4 \times \text{radius of armature} \times M\,max}{\pi}$$

In our example the radius of armature is 4.75 inches and the $M\,max$ is 110 pounds. The total magnetic pull therefore

$$= \frac{4 \times 4.75 \times 110}{\pi} = 665 \text{ pounds.}$$

When the unbalanced magnetic pull is acting in the same direction as the weight of the rotating part the shaft is subjected to its worst strain. Therefore by adding those two forces we get the resulting force

$$W = 665 + 150 = 815 \text{ pounds.}$$

In general the location of this force W on the shaft will practically lie on the center line of the armature.

The forces R_1 and R_2 acting on the bearings, as shown in Fig. 1, will be found from the following equations:

$$R_1 = \frac{W \times b + P \times (c + L)}{L} = 1{,}680 \text{ pounds}$$

$$R_2 = W + P - R_1 \qquad = \quad 75 \text{ pounds}$$

Diameter of Shaft.

The diameter of shaft at W, in Fig. 1, can now be figured. The bending moment at W is:

$$M_b = R_1 \times a = 13{,}650 \text{ inch-pounds.}$$

The twisting moment for 18.75 H. P. and 700 R. P. M. is:

$$M_t = \frac{18.75}{700} \times 63{,}024 = 1690.$$

The combined moment M_c of M_b and M_t is:

If M_b is greater than M_t
$M_c = .975 \times M_b + .25 \times M_t$;
or if M_b is less than M_t
$M_c = .6 \times M_b + .6 \times M_t$.

VALUES OF C_1 FOR 15° INVOLUTE TEETH OF ONE INCH FACE WHICH PRODUCE FIBRE STRESS OF 1000 POUNDS PER SQUARE INCH.

Number of Teeth in Gear.	Circular Pitch. 3.14	2.52	2.10	1.80	1.57	1.40	1.25	1.14	1.05	0.98	0.89	0.84	0.79	0.70	0.63	0.57	0.52
Diametral Pitch.	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4½	5	5½	6
12	210	168	140	120	105	93	84	76	70	65	60	56	52	47	42	38	35
13	220	178	147	126	110	98	88	80	73	68	63	59	55	49	44	40	37
14	226	180	151	129	113	100	90	82	75	69	65	60	56	50	45	41	38
15	236	189	157	135	118	105	94	86	79	73	67	63	59	52	47	43	39
16	242	194	161	138	121	107	97	88	81	74	69	64	60	54	48	44	40
17	251	200	167	143	125	112	100	91	84	77	72	67	63	56	50	46	42
18	261	208	174	149	130	116	104	95	87	80	75	70	65	58	52	47	43
19	273	218	182	156	136	121	109	100	91	84	78	73	68	61	54	50	45
20	283	227	189	162	142	126	113	103	94	87	81	75	71	63	57	51	47
21	289	232	193	165	144	128	116	105	96	89	83	77	72	64	58	52	48
23	295	236	197	169	147	131	118	107	98	91	84	79	74	65	59	53	49
25	305	245	203	174	152	136	122	111	102	94	87	81	76	68	61	55	51
27	314	250	210	180	157	140	126	114	104	97	90	84	78	70	63	57	52
30	320	256	213	183	160	142	128	116	106	99	91	85	80	71	64	58	53
34	327	262	218	188	164	146	131	119	109	101	94	88	82	73	66	59	54
38	336	263	224	192	168	148	134	122	112	103	96	90	84	75	67	61	56
43	346	277	230	198	173	154	138	126	115	106	99	92	86	77	69	63	57
50	352	282	235	200	176	156	140	128	117	108	100	94	88	78	70	64	58
60	358	286	238	204	179	159	143	130	119	110	102	95	89	80	71	65	59
75	364	292	243	208	182	162	146	132	121	112	104	97	91	81	73	66	61
100	371	297	247	212	185	164	148	135	124	114	106	99	93	82	74	67	62
150	377	302	251	215	188	167	151	137	126	116	108	100	94	84	75	68	63
300	384	308	256	219	192	171	152	140	128	118	110	102	96	85	77	70	64
Rack	390	312	260	223	195	173	156	142	130	120	112	104	97	87	78	71	65

Fig. 2.

In our example where $M_b > M_t$, $M_c = .975 \times 13{,}650 + 25 \times 1690 = 13{,}720$, approximately.

Now, if $f =$ fiber stress in shaft per square inch, and $D =$ diameter of shaft at W in inches, the moment of resistance

$$M_r = .1 \times f \times D^3$$

Therefore if we put $M_r = M_c$,

$$D = \sqrt[3]{\frac{M_c \times 10}{f}}$$

If we suppose a fiber stress $f = 8{,}500$ pounds per square inch, we get

$$D = 2\tfrac{1}{2} \text{ inches approximately.}$$

The minimum diameter of shaft in the bearings can be figured in the same manner; for instance at R_1 we get

$M_b = 5{,}050$
$M_t = 1{,}690$
$M_c = 5{,}340$

which give us a minimum diameter at $R_1 = 1\ 13/16$ inches, approximately. It is of course an advantage, however, to have the diameters of the journals somewhat larger than calculated. In this case the mechanical conditions may give a diameter at $R_1 = 2\tfrac{1}{4}$ inches.

Calculation of Journals.

In the bearings it is not advisable to exceed a pressure per square inch of 150 pounds, nor should the product of this pressure by the peripheral velocity in feet per minute in the journal be greater than 55,000, when grease lubrication is used. For oil lubrication this product can be somewhat higher. If in our example we assume a pressure of 130 pounds per square inch, with the diameter of shaft at $R_1 = 2\frac{1}{4}$ inches, we obtain length of journal $= \dfrac{1680}{130 \times 2.25} = 5\frac{3}{4}$ inches. At 700 R. P. M. and diameter of shaft $= 2\frac{1}{4}$ inches, and a pressure of 130 pounds per square inch in journal, the product of pressure by velocity will be $= \dfrac{130 \times \pi \times 2.25 \times 700}{12} = 53{,}500$, approximately.

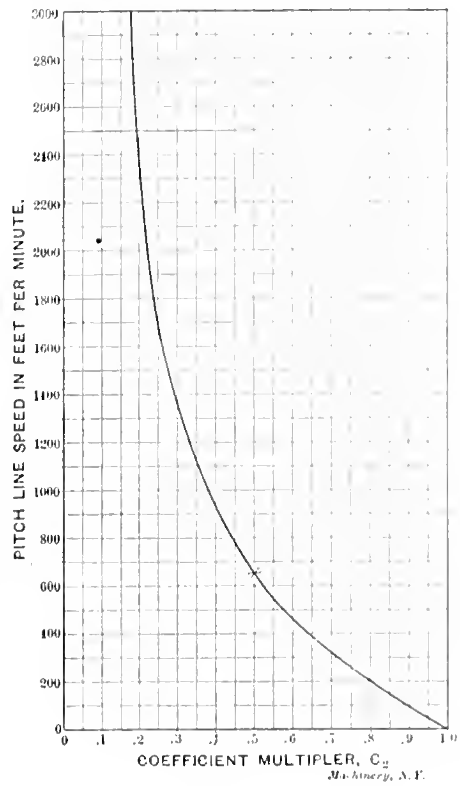


Fig. 3.

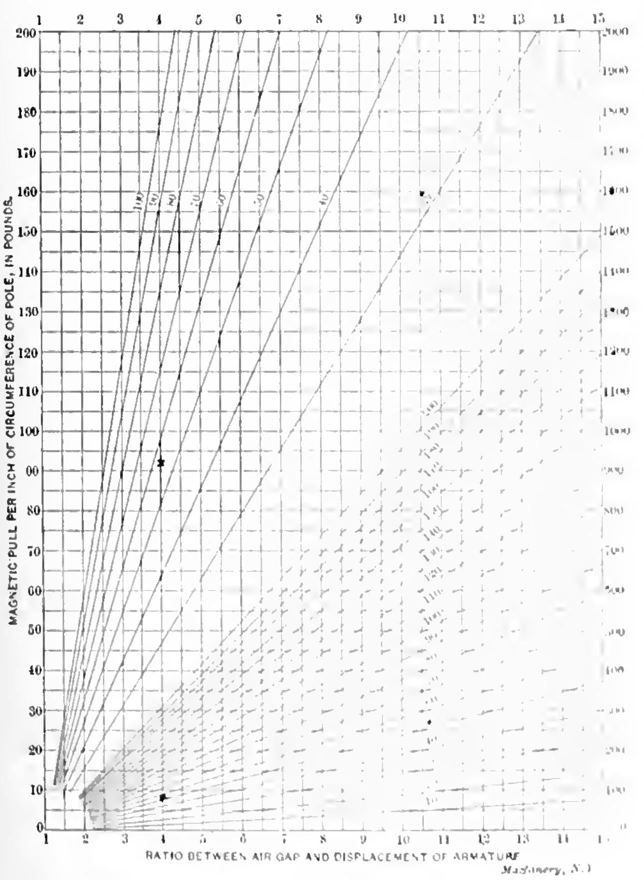


Fig. 4

Maximum Deflection of Shaft.

For calculating the maximum deflection S of the shaft we have the following formula:

$$S = \frac{W \times a \times b\,(2L - a)}{9 \times E \times I \times L}\sqrt{\frac{a\,(2L - a)}{3}}$$

where S is in inches and

W = the resulting force acting on the shaft in pounds,
L = distance between centers of journals in inches,
a = shortest distance between center line of one bearing and the acting point of force W,
$b = L - a$ in inches,
E = Modulus of elasticity,
= 29,000,000 for steel,
= 27,000,000 for wrought iron,
I = moment of inertia of shaft, $= .0491 \times D^4$, where D is the diameter of shaft in inches.

In this example we get the maximum deflection,

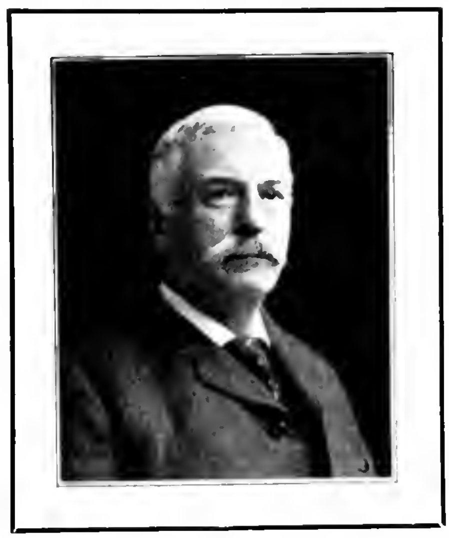
$S = .0027$ inches approximately.

Most of the formulas given above are empirical, and give only approximate results, but they are exact enough for practical use.

• • •

DEATH OF MR. GEORGE A. GRAY.

Mr. George A. Gray, the founder and for many years president of the G. A. Gray Company, Cincinnati, O., died suddenly at his home in that city, on June 14th, of heart trouble. Mr. Gray was born in 1839 on a farm in Illinois and his boyhood was spent there. Later he came to Cincinnati and served an apprenticeship with Miles Greenwood, devoting his attention to the study of mechanics; after which, with Messrs. Gordon & Gaff, he bought the machine tool department of the old Niles Works which had been started by a man named Niles on Front Street, east of Butler, calling the new firm Gaff, Gray & Gordon. After continuing at that location for several years the plant was removed to Hamilton, Ohio, and the name changed to Niles Tool Works. Later Mr. Gray sold his interest in the firm and started the manufacture of planers in Cincinnati, in which business he continued until last May, when he retired from the active management of the company which bears his name.



Mr. Gray's mechanical experience covered a wide field. As a young man during the Civil War he was engaged in building monitors for the United States Government, and about the same time he invented a multiple firing gun, the first of its kind that was ever made. He was universally regarded as the foremost mechanic in his line.

Mr. Gray was a man of singularly attractive character, quiet and retiring in his ways, but a good friend and upright in all his business dealings. His death will cause great sorrow to all those with whom he was associated by ties of friendship or business.

LOAD ON A JIB CRANE.

DYER SMITH.

A reader of MACHINERY has propounded a very interesting problem in connection with the strength of a jib crane. He states that the column of the crane, as shown in Fig. 1, is cast iron, has all the appearance of being sound, and is supposed to have ¾ inch of metal. The dimensions are as per sketch. The compression member consists of two 7-inch channels, weighing 11¼ pounds per foot, arranged back to back with a 3-inch space between them for the trolley to operate in. These are fastened together at each end, and the outer ends are supported by two 1-inch rods. The question raised is whether it will be safe to suspend 4 tons from the end of the 11-foot jib.

Calling a ton 2,000 pounds, the force conditions, reduced to simplest terms, will be as shown in Fig. 2. A compound beam with compressive stress, as indicated in the lower part of Fig. 2, would evidently be an equivalent case. Considering the column as a compound beam, the moment diagram will be as shown in Fig. 3. From this it will be seen that the

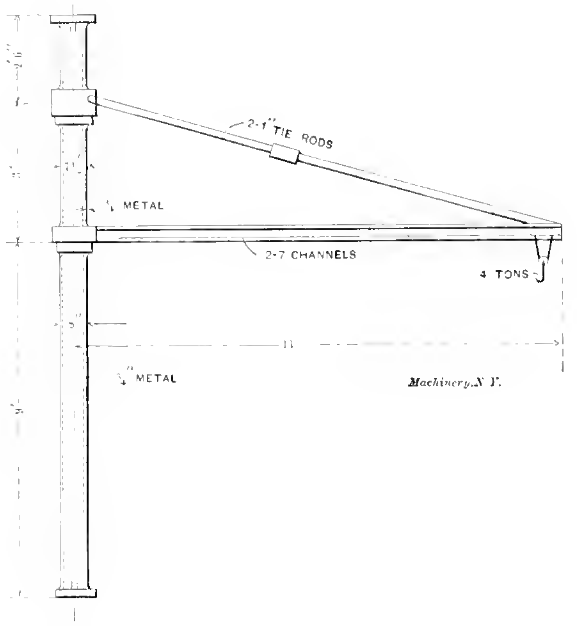


Fig. 1. Sketch of Jib Crane.

maximum bending moment on the column equals 54,614 foot-pounds, exerted in the axis of the jib, or 5½ feet from the upper end of the column.

To find the maximum fiber unit stress for the case of a beam subject to flexure by transverse loads and also to compression in the direction of its length, we find in Merriman's Mechanics of Materials, 9th edition, page 267, the formula

$$S_1 = \frac{M\,c}{I - \dfrac{n\,P\,l^2}{m\,E}}$$

where S_1 = maximum fiber unit stress,

M = maximum bending moment in pound-inches,

c = distance from the neutral axis to the remotest fiber,

I = moment of inertia of the cross section,

P = longitudinal compressive force = 8,000 pounds,

E = coefficient of elasticity = 15,000,000 pounds per square inch for cast iron,

n-m = numbers depending on arrangment of ends and kind of loading,

l = length of span of the beam, in inches.

In the above, M, the maximum bending moment, = 54,614 foot-pounds = 54,614 × 12 inch-pounds, and c = 3¾ inches.

I, for hollow column, = .0491 $(d^4 - d_1^4)$, where d and d_1 are the external and internal diameters, 7½ and 6 inches, and hence I = 91.5. The approximate value of $\frac{n}{m}$ is 1-12. The span l, in the equivalent case of the compound beam, is closely the distance between supports, or in our case, 144 inches. Hence we have

$$S_1 = \frac{54{,}614 \times 12 \times 3\tfrac{3}{4}}{91.5 - \dfrac{1}{12}\,\dfrac{8{,}000 \times 144 \times 144}{15{,}000{,}000}}$$

= 27,150 pounds per square inch.

To this should be added $\frac{P}{A}$, where A is the cross sectional area of the column, for the maximum compressive unit stress.

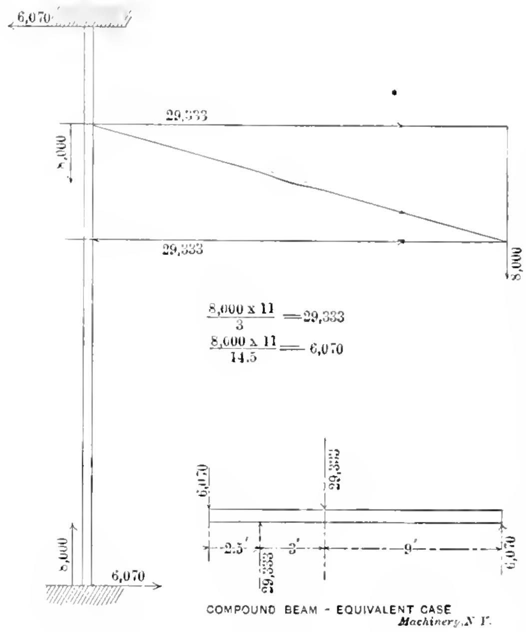


Fig. 2. Forces Acting on Column of Crane.

A = 15.9 inches, making $\frac{P}{A} = \frac{8{,}000}{15.9} = 503$, and hence $S = S_1 + \frac{P}{A}$ = 27,650 pounds per square inch, for compression.

For tension, $S = S_1 - \frac{P}{A}$ = 26,650 pounds per square inch.

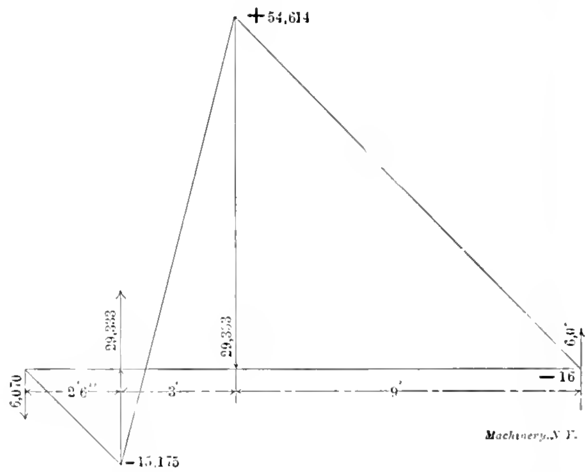


Fig. 3. Moment Diagram for Crane Column.

Since the average ultimate strength of cast iron in tension is 20,000 pounds per square inch, it follows that the column will probably fail when a load of 8,000 pounds is lifted at the end of the jib.

The above method applies also to the discussion of the channels which are under combined flexure and compression. The slenderness-ratio of this column is too large for good engineering practice, and entirely insufficient for a load of 4 tons.

* * *

Copper-vanadium is said to be possessed of great resistance and hardness. Copper-vanadium alloys in different proportions are recommended as being suitable for the manufacture of guns, propeller blades, valves, steam turbine blades, and for many other uses for which a hard copper alloy possessing great tensile strength is required.

ESTIMATING THE COST OF MACHINE WORK.

J. A. WEBSTER.

J. A. Webster.

I have seen numerous articles, both in MACHINERY and other technical periodicals, relating to estimating in the abstract, but very rarely anything in the nature of a concrete example; and while the articles have generally been good and interesting reading, it seems to me that to take up a machine in detail, and analyze the various operations to be performed, will be of equal or greater value to the young machinist.

For instance, there has lately been placed on the market a pencil sharpening machine which presents some operations that appear at first, if not somewhat difficult, at least not easy to perform economically. We were requested to estimate on making a set of tools suitable for turning out the parts so they would be interchangeable, and also for making the first 1,000 machines.

There are some 24 parts in the machine which are shown in detail in the figures throughout the text, numbered to correspond with the part numbers, and a sectional view of an assembled machine is shown in Fig. 1.

In making up the estimate the following order was adopted: First, the amount of material required for the various parts was calculated, then each part was taken up, methods of machining considered and discussed, the time required for the different operations estimated and tabulated, and lastly the cost of the tools required was made up. The experience of the writer is that it is best to leave the tools to the last for the reason that it is generally necessary to analyze the operations in detail in order to decide what tools must be made, and while doing this it is most convenient to tabulate the time required to do the work.

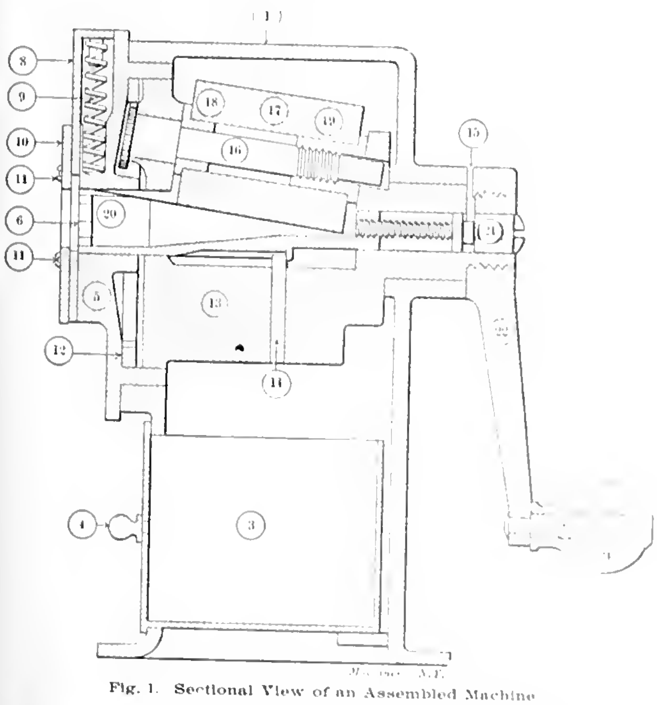


Fig. 1. Sectional View of an Assembled Machine

We were furnished a working model that was substantially accurate in all its details, and the weights of the cast iron parts were not calculated, but obtained by weighing those of the sample and adding 20 per cent. for loss in machining, broken and spoiled parts, etc. While this is sufficiently accurate for small articles, and saves time, on heavy castings it is best to calculate the weights as accurately as possible.

The cast iron parts of the sample weighed $2\frac{1}{2}$ pounds. Adding 20 per cent., as above, gives 3 pounds as the weight for one set. As the castings are light, and to facilitate machining, must be of the very best quality of soft gray iron, and part marked No. 1 is cored work, the price was set at $6\frac{1}{2}$ cents per pound. The price at which the order was afterward placed was 7 cents and the average weight 2.88 pounds.

The weight of the other materials was all calculated, and the whole tabulated as below.

Cast Iron.

Parts 1, 5, 13, and 22......3 lb. per set, 3,000 lb. at $6\frac{1}{2}$c.,	$195

Bessemer and C. R. Rods.

Part 2, 3-16 in. dia........	50 feet	5 lb	
Parts 7, 14, and 15........	150 feet	4 lb.	
Part 16, $\frac{1}{2}$ in. dia........	200 feet	131 lb.	
Parts 4 and 21, 5-16 in. dia..	110 feet	28 lb.	
Total..168 lb. at 5c......			8.40

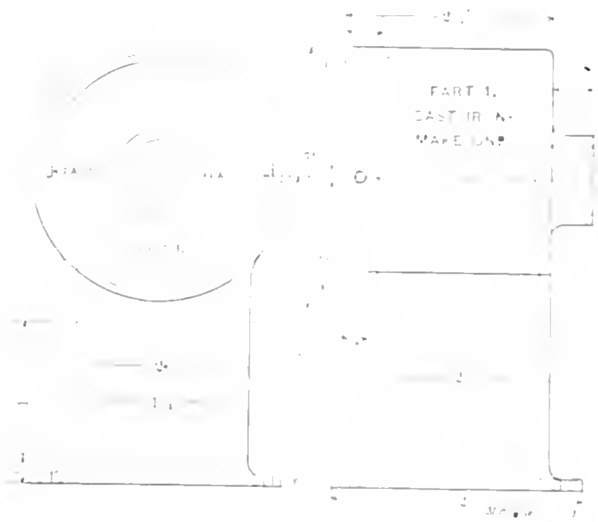


Fig. 2

Flat C. R. Steel.

Part 6, $\frac{1}{8}$ x $\frac{3}{8}$ in..........167 lin ft.	26 lb. at 8c.....	2.08
Part 3, 1-16 in. thick...... 24 sq. ft		
Part 8, 1-16 in. thick....... 20 sq. ft.		
Part 10, 1-16 in. thick..... 18 sq. ft.		
Total 62 sq. ft. = 161 lb.		
Part 3, 1-32 in. thick......121 sq. ft. = 157 lb		
	Total.... 318 lb. at 5c..	15.90

Tool Steel Annealed.

Part 17, 1 1-16 in. dia......125 feet 377 lb. at 16c.....	60.32

Piano Wire.

Part 9.....................1 lb........................	.50

Round Brass.

Part 18, $\frac{1}{2}$ in. dia....	27 feet.	
Part 19, $\frac{1}{2}$ in. dia......	55 feet.	
Part 20, $\frac{1}{2}$ in. dia.........	212 feet.	
Total	294 feet = 209 lb. at 16c	$33.45

Half Hard Sheet Brass.

Part 12, 1-16 in. thick ......80 sq. ft. = 220 lb. at 15c.	33.00	
	66.45	
Less 100 lbs. scrap at 7c.	7.00	
		59.45
Rivets for part 3		.50
Part 11, 3 x 18 x $\frac{1}{4}$ R. H. Iron Mch. Screws, 27 gross at 15c.....		4.05
Part 24, Hard Maple, 1,000 pieces		3.70
Total		$[illegible]49.70

In addition to the above, it was required to supply and pack with each machine four $\frac{3}{4}$ inch No. 7 R. H. wood screws. Each machine must be wrapped with paper and packed in a locked-corner, wooden box and these packed two dozen in a case and delivered f.o.b. cars. So we have:

27 gross screws at 15c.	$4.05
1,000 individual boxes	15.00
42 cases at 30c.	12.60
	$31.65

Parts 1, 5 and 22 were required to be enameled in black, two coat work, and parts 8 and 10 and the front plate of part 3 nickel plated and polished. As we did not have facilities for

JOHN A. WEBSTER was born at Berrien Springs, Mich., 1852. He received a business education and practiced architecture in New York for ten years, but finally found that machine work was more to his taste. He has served as designer and superintendent and in various other positions of trust for several concerns in New York City. His specialty is devising means and tools for difficult work in metal.

doing this, they would have to be sent out, so it was necessary to add the cost of cartage back and forth.

Enameling parts 1, 5 and 22, 1,000 sets at 6c..	$60.00
Nickel plating parts 8, 10 and front of part 3, 1,000 sets at $2.65 per 100................	26.50
Cartage	1.50
	$88.00

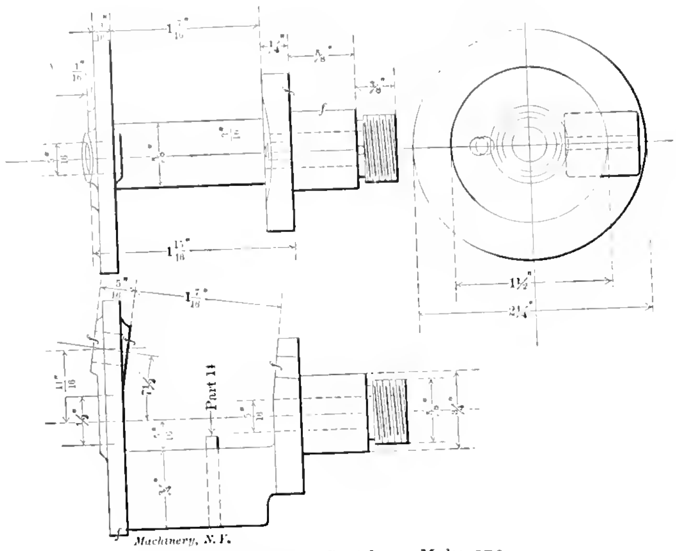
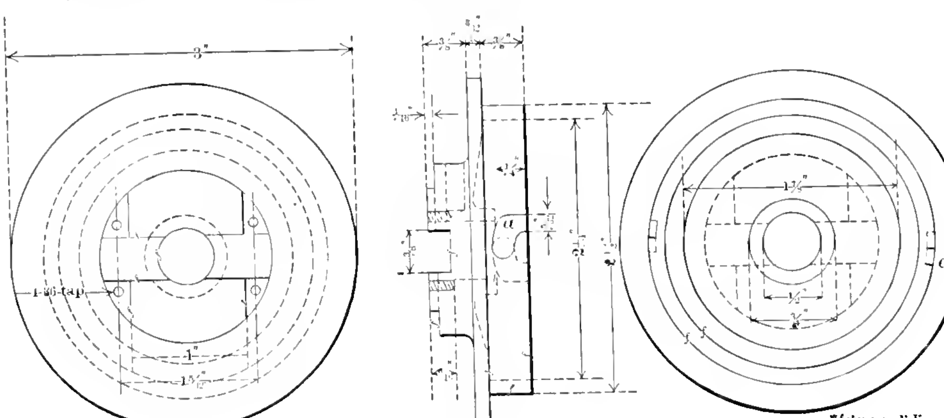


Fig. 3. Part 13—Cast Iron—Make one.

This brings the total cost of material, packing and work required to be sent out to $469.35, to which we thought wise to add to cover freight, express and cartage on materials and finished goods $10.65, making a total of $480.00.



PART 5-CAST IRON-MAKE ONE.
Fig. 4.

Coming to the estimating of labor, we listed it under three classes of employees, viz., toolmakers, journeymen and boys, and calculated the time required for the whole lot of 1,000 machines.

The first item considered was the cleaning and snagging of castings. Part 1 being a cored piece, it was expected that there would be considerable work on this, but the other parts could be tumbled in the foundry and would come to us clean and in good condition to put on the machines. The work of cleaning all the castings appears in the first item in table headed Labor.

Taking up part one, we concluded to put it on a monitor lathe for the first operation, holding it in a two-jawed chuck, the jaws of which were made to fit the casting. Here we would drill and ream the hole in the hub, face the inside boss, and follow by boring and facing the opposite large end of the casting. For this boring and facing operation two tools would be required, one for the roughing and another for the finishing cuts. The next operation is facing the outer end of the hub, which would be done on a drill press, using a counterbore and running down to a stop. The casting could now be placed in a jig, accurately located by the finished surfaces and the holes, seven in number, drilled, which completes the machine work on this part.

For the operations on the monitor lathe, we allowed time as follows: Chucking, ½ minute; drilling and reaming, ½ minute; rough boring, 1¼ minutes; finish boring, ¾ minute; total, 3 minutes, or 20 pieces per hour. We worked 9 hours per day, but to cover time lost in grinding tools and incidental delays that almost always occur, it is our custom to figure on only 8 hours actual work. This would give 160 pieces finished each day, or 6¼ days for the lot. For good measure we put it down in the table as 7 days. Operations of this kind require more or less of the foreman's time in adjusting tools, etc., and to cover this it is our practice to add a percentage of the time, placing it in the column marked "toolmaker." In this case we allow ten per cent., or 6 hours for even figures.

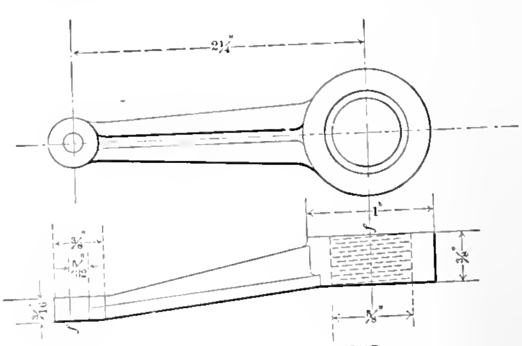
The counterboring of the hub will go quite rapidly, but as much time will be required to handle and move the pieces as to do the work. Still, the whole lot should be handled in 1½ days, and the job will not require so much of the foreman's time, as before, so we will put only one hour in the "Toolmaker" column.

In the final operation of drilling, we will allow ½ minute to place the piece in the jig and remove it and 1½ minutes to do the drilling, which gives 30 per hour, or 240 per day. For good measure we will say 4½ days for the lot, with 3 hours in the toolmaker column.

Next we will take up part 5. As before, the first operation is on the monitor lathe, and as the piece has a good-sized round hub, it can be held in a three-jaw chuck, though it will probably be better to use the two-jaw and make special jaws to fit the castings. At this operation we will drill the ½-inch hole, bore and face to receive the internal gear, and turn down on the outside and shoulder to fit in Part 1. As before we will use roughing and finishing tools, and for the last sizing cut will use a tool in the slide rest in order to secure greater accuracy.

For the chucking we will allow ½ minute; drilling and reaming, ½ minute; boring and facing for gear, rough and finish, each one minute; turn and shoulder, 1 minute; and sizing finish, ½ minute, making a total of 4½ minutes, or about 13 pieces per hour. Say 100 pieces per day. This will require 10 days for the lot and we will put 1 day in the Toolmaker column, as the foreman will have to watch this work rather closely

Next we will have two milling operations which we will calculate to have going on at the same time on two adjoining millers, so that one boy can attend both machines, changing the pieces on one while the other is running. This faces the hub and cuts the slots for parts 6 and 8. To insure accuracy in the width of these slots, we will use interlocking cutters, and special jaws will be required for the miller vises.



PART 22. - CAST IRON. - MAKE ONE.
Machinery, N.Y.

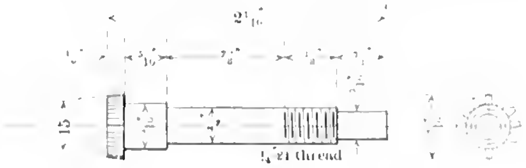
Fig. 5.

In fixing the time, we again take each movement in detail, but it is not considered necessary to set down the time for each here, as it would make this article very lengthy and probably wearisome. The time decided on as necessary for the different operations will be found in Table No. 1.

The third operation will be drilling the holes for screws and spring, and will be done in a jig, after which the screw holes

will be tapped. The fifth and final operation is milling the two bayonet slots (*a a*) that engage the two pins in part one. It is necessary that these be very accurately located and of the same profile, so that the shoulder will come to a bearing on both sides at the same time. This was a matter to which we gave considerable thought and finally decided to make a special machine to do the work. The reasons for this decision were that our millers did not run at a high enough speed for such small mills (5-32 inch diameter), that to speed up a machine and make a fixture would cost about two-thirds as much as a complete machine, and finally that we could make the special machine cut both slots at the same time. (A description of the machine that was afterward made for this work was published on page 492 of the May, 1904, issue of MACHINERY.)

Taking up next Part 13, we find a piece that will require very careful handling all through, for if this part is not correct, there will be trouble when the machine is assembled. This

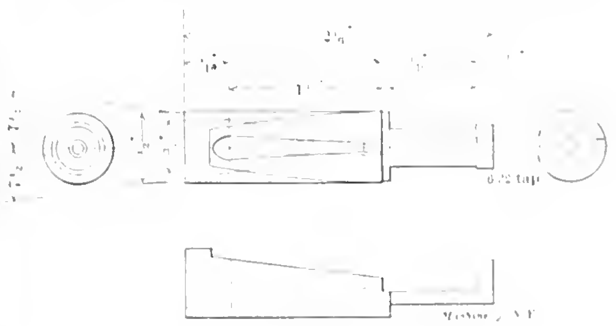


PART 16-MCH STEEL-MAKE ONE.
PINION-P.D. $\frac{3}{8}$" O.D. $\frac{7}{16}$" PITCH 32-12 TEETH.

Fig. 6.

part revolves on two bearings, one of which is the shaft end to which the crank is attached, and the other the projecting end of part 20, which fits in the central holes, so that these holes must be in line and the shaft concentric and in line therewith. The two holes for the bearings of part 16 must be accurately located with relation to the axis on which the part revolves, all of which leads to the conclusion that the proper place to begin the work is with the central holes through the part.

For the first operation we will chuck the piece in the monitor lathe, by the hub end, and drill the ½-inch hole through the larger disk and the 5-16-inch hole through the hub end, reaming both holes with a special reamer to insure their being in line. For the second operation we will put the piece on a mandrel, turn and face the hub end, and size the large disk. Cutting the screw threads and facing the boss on the large disk will constitute the third and fourth operations. The fifth operation will be milling the disks to form the bearings for



PART 20-BRASS MAKE ONE.

Fig. 7.

the shoulder of part 16 and the bushings 18 and 19, and for this we will make a special holding fixture to insure the cuts being made in proper relation to the central holes. Drilling the holes in a jig will form the sixth operation, and to insure accuracy we will ream the holes for the cutter shaft (part 16) in a jig, making seven operations in all. In all the fixtures used, the work will be located by a pin or mandrel passing through the central holes, and by this means we should be able to produce parts that are exact duplicates.

Next we will take up Part 22, which is quite simple. We will hold it in a chuck with special jaws on the monitor, drill, counterbore and tap the large hole and then drill and counterbore the small hole in a jig on the drill press.

Taking up next the round-rod parts, we find two—Parts 16 and 20— that will require to be made with great care. Considering first, Part 16, it is apparent that the bearings upon which it turns and the parts of the shaft upon which parts 18 and 19 fit, must all be in line, concentric, and of accurate dimensions, otherwise the cutter will run out of true and cut upon only one side. Such work being almost impossible to produce on the screw machine, we will calculate on finishing the piece with the exception of that part which fits in part 18, which we will leave slightly over size. To complete the shaft, we will make a special chuck and steady rest for the precision bench lathe and finish the shaft together with the shoulder, on this machine. While this makes an additional

PART 18-BRASS-MAKE ONE

PART 19-BRASS-MAKE ONE

Fig. 8

operation and adds to the cost of tools, it will save time in assembling, a thing that should never be lost sight of. There yet remains to cut the teeth of the pinion, which is accomplished by setting it at the proper angle and treating as if it were a simple spur gear.

Analyzing part 20, it is seen that the cone-shaped hole should be concentric with the outside, otherwise the pencil being supported centrally by the holding chuck would be given a wabbling movement as the machine was turned, and there would be liability that the point of the lead would be broken. To drill and ream this hole concentric with the outside would hardly be practicable, so we will use stock 1-32 inch over size and finish the pieces on a mandrel in the precision lathe. After

PART 17-TOOL STEEL MAKE ONE.

Fig. 9

this there will be two milling operations to finish the part.

Parts 18 and 19 will also need to be made with considerable care, but present no special difficulties. The holes should be true with the outside and the thickness of the flanges should not vary. The holes must be left somewhat undersize so they may be reamed after being forced into the cutter.

The remaining round parts 2, 4, 7, 14, 15, 21 and 23 are quite simple, and will need no special mention.

Next we will consider Part 17. We have a universal mill-

Fig. 10

ing machine upon which we [illegible] handle pieces 18 inches in length, so we will cut the bars that length, center and turn down to finish size. In order that we can mill the full length we will put a [illegible] inch hole in one end 1 7-16 inch deep and in this we will force a short piece of [illegible] inch drill rod, which we can catch in the split chuck of the indexing fixture. We will make a special indexing fixture and provide a rest for the bar under the cutter. We will also make a

special cutter of high-speed steel. With this we should be able to mill about 2½ inches per minute. Making allowance for indexing, changing and grinding cutter, we can count on averaging 125 inches per hour. The length of a 45-degree spiral on an 18-inch bar is 25½ inches, and as there are 12 teeth to cut, we will have 306 inches to cut on each bar. One bar will make 12 parts. So we will require 83 1-3 bars for 1,000 parts. As some will probably be lost in hardening, we will mill 87 bars, which, multiplied by 306, gives 26,622 inches as the total length to be milled. Dividing by 125, the number of inches milled in one hour, we have 213 hours, or 26 days 5 hours. For good measure we will say 28 days.

The next operation will be to remove the burr raised by the cutter, and to do this we will make a hollow mill which can be run over the bars. Next we will drill, ream and cut to length, when the parts will be ready for hardening. After they are hardened the bushings must be forced in, which can be done very readily with a foot press. When both bushings are in place they must be reamed with a special hand reamer, which makes all ready for the final operation of grinding the teeth.

Taking up, now, part 6, we will cut to length with a shearing die, mill the end as shown and drill the hole for the small pin in a jig.

The remaining parts with the exception of the helical spring which is wound on a mandrel and cut to length, are of sheet metal, and taking up No. 3, we find it composed of two pieces. The front consists of a flat piece of steel 1-16 inch thick, pierced with five holes and having stamped on its surface the name and address of the manufacturers, etc. As no great accuracy is required here, we will make a combined blanking and piercing die. For the second part we will require a blanking and two forming dies. Part 8 will require a blanking, two piercing and one forming dies; part 10 will need only one combined blanking and piercing die.

Part 12 is composed of two similar pieces assembled together. We will first blank out in rings and afterward cut the teeth at a single and final operation. To secure a good result these dies must be made with the greatest accuracy, and the work very carefully handled.

Having now covered the making of all of the parts, we will take up the assembling and tabulate the time required for this in Table No. 2. Beginning with part 1 we have only to put in the two pins that engage in the bayonet slots of part 5.

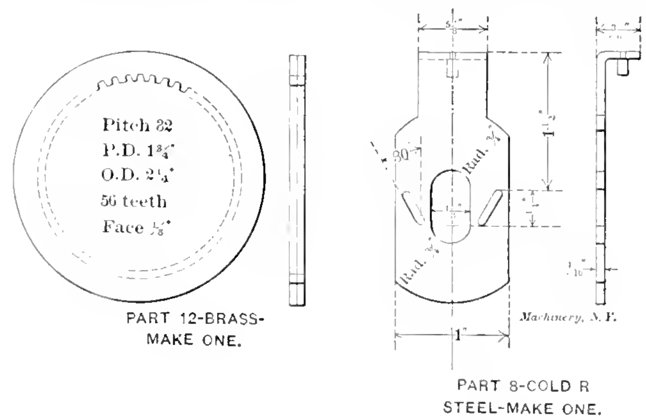


Fig. 11.

As the castings will vary somewhat in thickness, we have cut the pins a little long and will make a fixture for the foot press that will enable us to force them in against a stop which will leave the inner end projecting the proper distance. The outer end will then be filed off flush with the surface of the casting.

Taking next part 5 we will force the internal gear No. 12 into place. This work we will calculate to do on the power press, having made fixtures to accurately locate and guide the gears. We will hope to make our parts so exact that friction will hold the gears in place, otherwise they will have to be pinned to prevent turning. We are now ready to assemble Parts 5, 6, 8, 9 and 10. The putting together of these parts is so plainly shown in the drawings that it is not necessary to describe it in detail.

Part 13 is next in order. We will first force pin 14 in place, making provision in our means for doing this to insure the end projecting to the proper height. Then we will put Part 21 in place and drive in retaining pin No. 15, being careful that it does not come down hard on the screw and prevent its turning. We can now slip in Part 20 and turn screw 21 until it is drawn into place. Next we will press the two bushings 18 and 19 into the cutter 17. In case we have not done our work perfectly and the lengths when assembled vary we shall have to counterbore the bushing at one end, preferably No. 18, to bring them all to the same length.

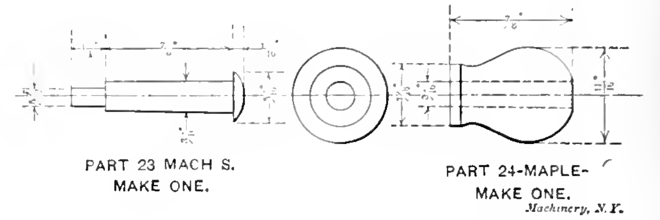


Fig. 12.

We have now remaining only the riveting together of No. 3, and the assembling and riveting together of Nos. 22, 23 and 24, when the machine is ready to put together, and the design is such that this is readily done without the use of tools.

TABLE NO. 1.

Labor: Cleaning Castings and Machining Parts.

Part No.	Operation.	Toolmaker. Days.	Toolmaker. Hrs.	Journeyman. Days.	Journeyman. Hrs.	Boy. Days.	Boy. Hrs.
1-5-13 and 2	Snagging and cleaning castings					4	0
1	Drilling and boring—monitor.	0	6			7	0
	Counterboring—drill press....		1			1	4
	Drilling—jig—drill press.....		3			4	4
		1	2			13	0
5	Drilling and boring—monitor.	1	0			10	0
	Milling chuck part slats—2 milling machines		5			6	0
	Drilling—jig—drill press.....		2			4	0
	Milling bayonet slots—special milling machine		3			3	4
		2	2			23	4
13	Drilling and reaming—monitor		3			4	0
	Turning and facing—engine lathe		1	5	0		
	Cutting screw threads—monitor lathe opening dies.....		2			3	0
	Facing boss—drill press—counterbore		1			2	0
	Milling bearings—milling machine		2			3	4
	Drilling—jig—drill press.....		1			4	0
	Reaming—jig—drill press ...			2	0		
		1	2	7	0	16	4
22	Drill counterbore and tap—monitor		2			4	0
	Drill and counterbore—drill press					1	0
			2			5	0
16	Forming—screw machine.....		3			4	0
	Turning—precision lathe			4	0		
	Cutting teeth in pinion—milling machine		5			10	
		1	0	4	0	14	0
20	Forming—screw machine		3			4	0
	Turning—precision lathe			2	0		
	Milling—1st operation—milling machine		2			2	0
	Milling—2d operation		1			1	0
	Burring					2	0
			6	2	0	9	0
18	Forming—screw machine.....		2			1	4
19	Forming—screw machine.....		3			3	0
2	Forming—screw machine.....		2			1	0
4	Forming—screw machine.....		3			2	0
7	Forming—screw machine.....		2			1	0
14	Forming—screw machine.....		1				5
15	Forming—screw machine.....		1				4
23	Forming—screw machine.....		3			2	5
		1	4			7	6
21	Forming—screw machine.....		4			3	0
	Slotting—hand miller........		1			1	0
			5			4	0
17	Cutting to length—power hack saw					1	0
	Centering and drilling engine lathe			2	0		
	Turning engine lathe			1	4		
	Cutting drill rod—screw machine		1			3	0
	Milling teeth—universal miller	2	0			28	0
	Burring						4

Part No.	Operation.	Toolmaker. Days.	Hrs.	Journeyman. Days.	Hrs.	Boy. Days.	Hrs.
	Drill, ream and cut off—monitor			7	0		
	Face to length drill press counterbore					3	0
	Hardening	4	0			4	0
	Grinding	2	0			10	0
		8	1	10	0	49	4
6	Cutting to length—power press		1				3
	Milling—milling machine		2			2	0
	Drilling jig—drill press		1			1	0
			4			3	3
9	Winding—speed lathe		1				4
	Cutting to length—special shear						2
			1				6
3	Blanking and piercing front—power press		1				2
	Stamping—power press		1				2
	Blanking second part—power press		1				3
	Forming — 1st operation — power press		1				3
	Forming — 2d operation — power press		1				3
			5			1	5
8	Blanking—power press		1				2
	Piercing — 1st operation — power press		1				3
	Piercing — 2d operation — power press		1				3
	Forming—power press		1				3
			4			1	3
10	Blanking and piercing—power press		1				3
12	Blanking—power press		2			1	0
	Cutting teeth—power press		2	1	4		
			4	1	4	1	0

SUMMARY.

Part No.	Operation.	Toolmaker. Days.	Hrs.	Journeyman. Days.	Hrs.	Boy. Days.	Hrs.
	Cleaning castings					1	0
1	3 operations	1	2			13	0
5	4 operations	2	2			23	4
13	7 operations	1	2	7	0	16	4
22	2 operations		2			5	0
16	3 operations	1	0	4	0	14	0
20	5 operations	6	0	2	0	9	0
18	1 operation		2			1	4
19	1 operation		3			3	0
2-4-7-14-15-23	1 operation each	1	4			7	6
21	2 operations		5			4	0
17	10 operations	8	1	10	4	49	4
6	3 operations		4			3	3
9	2 operations		1				6
3	5 operations		5			1	5
8	4 operations		4			1	3
10	1 operation		1				3
12	2 operations		4	1	4	1	0
	Total	25	2	25	0	159	2

TABLE NO. 2.

Labor in Assembling.

Part No.	Operation.	Toolmaker. Days.	Hrs.	Journeyman. Days.	Hrs.	Boy. Days.	Hrs.
1 and 2	Putting in pins		1				6
	Filing off pins			1	0		
			1	1	0		6
5-6-7-8-9-10 and 11	Forcing internal gears in place		2	2	0		
	Putting pins 7 into 6					2	0
	Putting together all parts and screwing on 10		1	1	0	1	0
			3	3	0	3	0
13-14	Forcing in pin 14		1			1	0
13-15-21	Putting in adjusting screw 21 and retaining pin 15		2	2	0	2	0
13 and 20	Putting in part 20 and screwing home		2	1	0	1	0
17-18 and 19	Forcing in bushings		1	1	0		
13-16 and 17	Putting together		2	1	0		
		1	0	5	0	4	0
3 and 4	Riveting knob to front		1			1	0
	Riveting front and box		3			4	0
			4			5	0
All parts.	General assembling, testing and adjusting	1	0	10	0	10	0

SUMMARY.

	Toolmaker. Days.	Hrs.	Journeyman. Days.	Hrs.	Boy. Days.	Hrs.
Group 1		1	1	0		6
2		3	3	0	3	00
3	1	0	5	0	4	00
4		4			5	00
General	1	0	10		10	00
	3	0	19		22	6

Taking now the various items of cost we have:

Labor for machining 25 days 2 hours toolmaker at $3.50	$88.38	
Labor for machining 25 days journeyman at $2.50	62.50	
Labor for machining 159 days two hours boy at $1.25	199.07	
	$349.95	
Labor for assembling—3 days toolmaker at $3.50	$10.50	
Labor for assembling—19 days journeyman at $2.50	47.50	
Labor for assembling—22 days 6 hours boy at $1.25	28.43	
		$86.43
		$436.38
To this we will add to cover shop superintendence and possible errors in estimating 15 per cent		65.46
		$501.84
Cost of materials and work done outside	$480.00	
To which we will add a profit of 10 per cent	48.00	
		528.00
		$1,029.84
On the item of labor cost we will add a profit of 33 1-3 per cent		167.28
		$1,197.12

This makes the price for a single machine a trifle less than $1.20, but we will put in our bid at $1.25 each.

The cost of tools would now be taken up and estimated in detail in much the same manner, but I shall give here only a list with the prices that we will charge the customer.

LIST OF TOOLS

Part	Tool	Price	Total
Part 1.	Four metal patterns, gated	60.00	
	Metal core box	25.00	
	1 pair chuck jaws	5.00	
	Boring tool—roughing	20.00	
	Boring tool—finishing	20.00	
	Counterbore	2.50	
	Drill jig	15.00	
	Gages	20.00	$167.50
Part 5.	Eight metal patterns, gated	25.00	
	1 pair chuck jaws	5.00	
	Boring tool roughing	25.00	
	Boring tool finishing	25.00	
	2 sets milling jaws	10.00	
	Interlocking milling cutters (2 pairs)	15.00	
	Drill jig	18.00	
	Tapping fixture	3.00	
	Special machine for bayonet slots	75.00	
	Gages	25.00	
			226.00
Part 13.	Eight metal patterns, gated	40.00	
	1 pair chuck jaws	7.00	
	Mandrel	2.00	
	1 pair chuck jaws	7.00	
	Counterbore	2.00	
	Milling jaws	5.00	
	Cutters and arbors	15.00	
	Drill jig	40.00	
	Reaming jig	15.00	
	Gages	20.00	
			153.00
Part 22.	12 metal patterns, gated	25.00	
	2 drill jigs	15.00	
	Counterbore	2.00	
			42.00
Part 16.	Screw machine box and forming tools	25.00	
	Precision lathe special rest	15.00	
	Milling fixture for cutting teeth	20.00	
	Gages	15.00	
			75.00
Part 20.	Forming tools	10.00	
	Reamers	7.00	
	Arbor for turning	3.00	
	2 sets milling jaws	6.00	
	Cutter and arbor	10.00	
			36.00
Part 18.	Forming tools		5.00
Part 19.	Forming tools		5.00
Part 4.	Forming tools		10.00
Part 21.	Box and forming tools		15.00
Part 17.	Milling fixture	20.00	
	Cutter and arbor	12.00	
	Hollow mill	3.00	
	Grinding fixture	40.00	
			65.00
Part 6.	Shearing die	8.00	
	Milling jaws	12.00	
	Cutter and arbor	8.00	
	Drill jig	8.00	
			36.00
Part 9	Cutting shear		6.00
Part 3.	Blanking and piercing die	20.00	
	Stamping punch	15.00	
	Blanking die	20.00	
	Forming die	30.00	
	Forming die	20.00	
			105.00
Part 8	Blanking die	15.00	
	Two piercing dies	25.00	
	Forming dies	8.00	
			48.00
Part 10.	Blanking and piercing		25.00
Part 12.	Blanking die	30.00	
	Die for cutting teeth	75.00	
			105.00
	Total		$1,124.50
	In addition to the above there are needed several fixtures for use in assembling and we will add to cover these		75.50
	Making the total for the tools		$1,200.00

The writer thinks the above covers the example selected quite fully and submits it in the hope that it may be thoroughly studied by many of MACHINERY's young readers.

* * *

Some definitions of early writers are entertaining, if not useful. One such is: "Iron is made up of salts of vitriol and earth badly combined"; another is: "Steel is of two forms—natural and made. When well cleaned and quenched several times in an extract of water and radishes, which has contained earth worms, it cuts iron like lead."

SPHERICAL BORING AND TURNING IN THE ALLIS-CHALMERS SHOPS.

The building of huge stationary engines with shafts of large diameter carrying flywheels and other rotating elements of great weight between bearings widely separated, has introduced the spherical or self-aligning bearing into large stationary engine practice generally. A nickel-steel shaft carrying a load, say, of 100 tons, 10 feet or more between bearings,

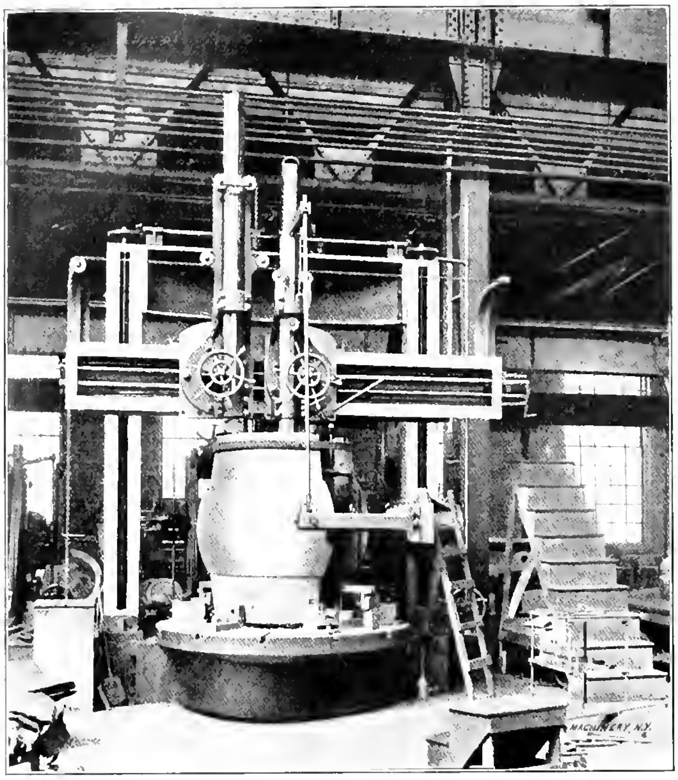


Fig. 1. Boring Mill with Rig for Turning Spherical Shells.

must be as elastic as a finely tempered steel spring, since its deflection in the center under the enormous load causes a constant bending action which may be repeated millions of times in its lifetime. It would be difficult to predict exactly what this deflection will be under all the varying conditions of load, etc., and if it were possible to do so it would be impracticable to bore the bearings at the proper angle to take care of the shaft deflection. Moreover, with bearings four feet long or more, a small variation from the calculated deflection would throw an enormous unit load on the sides of the bearings. So

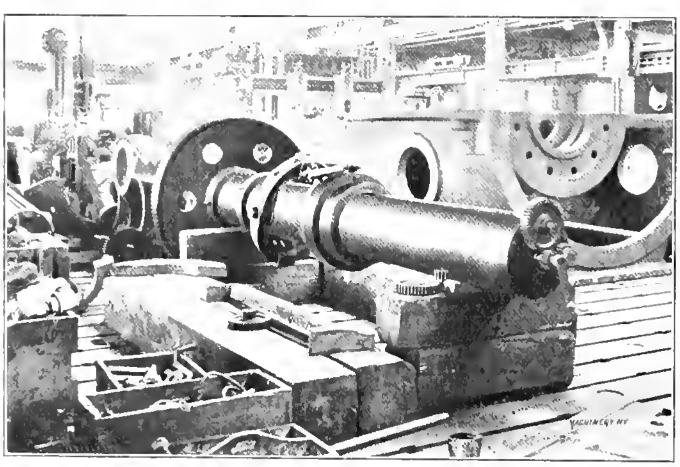


Fig. 2. Boring Bar for Boring Spherical Pillow Blocks, showing Feed Motion.

the deflection must be taken care of in some way automatically; this is done, as stated, by boring the pillow-blocks spherical and making spherical shell bearings for the shaft.

In the Allis-Chalmers shops at West Allis, an 8-foot Niles boring mill has been fitted up with an interesting rig for turning spherical shells, which is shown quite clearly in Figs. 1 and 4, herewith. A vertical slide is fitted to the stanchion or housing at the right, which carries another slide having a horizontal movement at right angles to the cross-rail. This slide is pivoted like a lathe compound rest, so that it may be swung vertically in the arc of a circle, and it carries a curved arm which projects over to the central plane of the mill. The pivot of the swinging slide is so located that the prolongation of its axis intersects the vertical axis of the boring mill table. At the outer end of the arm is the turning tool, which, as it is swung through the arc, generates a sphere on the surface being turned. The motion of the arm is controlled by the boring bar at the right, a rod being connected to the tool-post end and to the upper end of the boring bar, as indicated clearly in Fig. 4. At the upper end of the boring bar a double

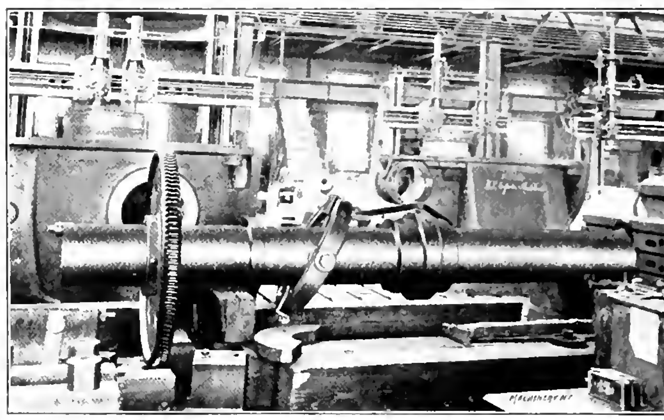


Fig. 3. Boring Bar for Spherical Boring, showing Driving Gear.

mortise is cut, in which a horizontal bar is fitted; and to this is connected the vertical rod which in turn is attached to the end of the swinging arm. The connections are pivoted so that the slide, on which the arm is mounted, may be moved in or out to accommodate shells of different diameters. The feed, of course, is taken from the boring bar.

The complementary tool, the boring bar for boring the pil-

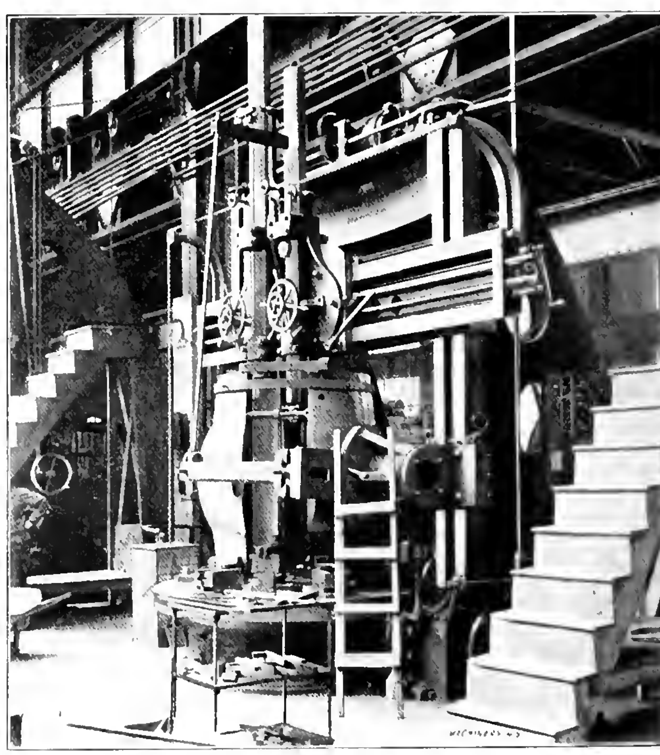


Fig. 4. View of Rig, showing Method of giving Tool Vertical Circular Feed.

low-blocks to the corresponding spherical shape, is shown in Figs. 2 and 3. The bar is driven by a worm and wormwheel, and the boring tools are carried on opposite ends of a loop-shaped swinging arm which is pivoted to the bar in its center. The swinging arm is connected by a link to the sleeve at the right, which is engaged by means of a nut with a feed screw lying in a longitudinal groove in the bar. The gearing oper-

ating the feed motion is clearly shown in Fig. 2; the feed motion is made automatic by simply holding the central pinion stationary while the bar revolves. The rig is substantially the same as that illustrated in MACHINERY in February, 1905, and which we believe was used in the Dickson works of the Allis-Chalmers Company at Scranton, Pa., for boring the pillow-blocks for the Brooklyn Rapid Transit Company's engines; but, in this case, the swinging arm is provided with tool posts at both ends so that cutters may be used on opposite sides of the bar to balance the thrust of the cut. The 12,000 H. P. engines for the Manhattan Elevated Railway and for the New York Subway power stations are fitted with spherical bearings which, we understand, were turned and bored with the tools illustrated.

* * *

TOOL CARRIERS.

OSCAR E. PERRIGO

The speedy and economical transportation of small tools to and from the general tool room is a problem that, while of acknowledged importance in any large establishment, is of sufficient moment in many shops of more moderate dimensions, and should receive a larger share of consideration than is generally given to it. The requirements of modern shop practice that the employees should not leave their machines to

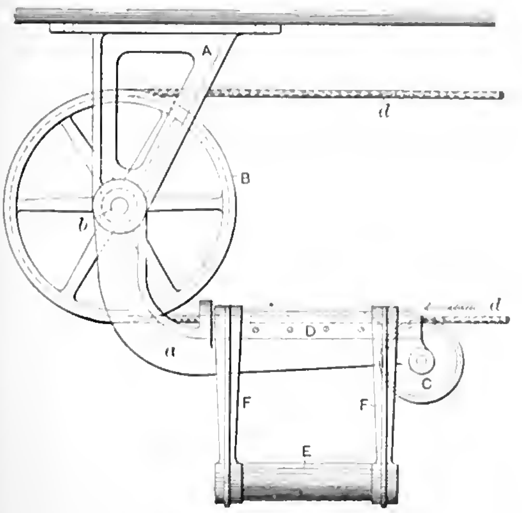


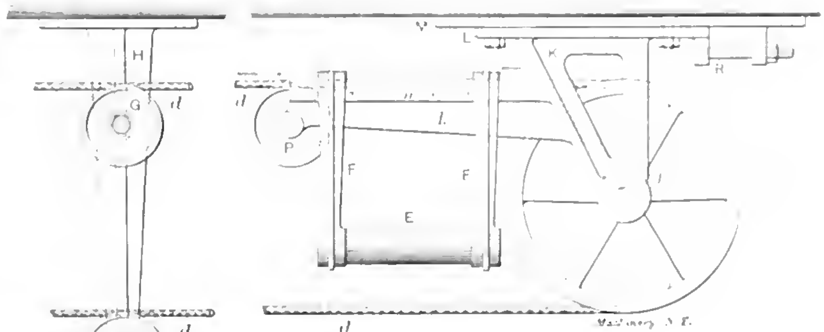
Fig. 1. Fixed Terminal Hanger of Horizontal Tool Carrying System.

grind tools, or to go to the tool room to procure or to return them, becomes a large factor in the problem of their quick transportation, and even with the system of errand boys to do this work there are many conditions of the modern shop where a good and efficient system of transportation in both vertical and horizontal directions becomes a necessity, if we consider economy along with efficiency. For instance: In a large plant of one floor, it may not be convenient to locate the tool room near the center of the machine shop for the purpose of shortening the lines of travel of the errand boys. Or, if so located, these lines may still be so long as to cause a considerable loss of time. In this case the establishing of auxiliary tool rooms, while of considerable advantage in the distribution of tools, still leaves the transportation problem untouched and out of the question.

Again, in shops consisting of several floors, as many in the crowded cities must necessarily be, the vertical transportation of tools from a general tool room to and from the several floors should be accomplished as quickly and with as little manual labor as may be.

These being the conditions, it becomes necessary to devise a system of transportation that will accomplish the required results in as economical and efficient a manner as possible, and at the same time occupy as little space in the shop as may be, and that shall not be liable to frequent interruptions from getting out of order. It must, therefore, be some overhead system, when used for horizontal transportation; it must be simple and of as few parts as possible so as to be inexpensive, and to be less liable to disarrangement; and it must practically take care of itself under all ordinary circumstances.

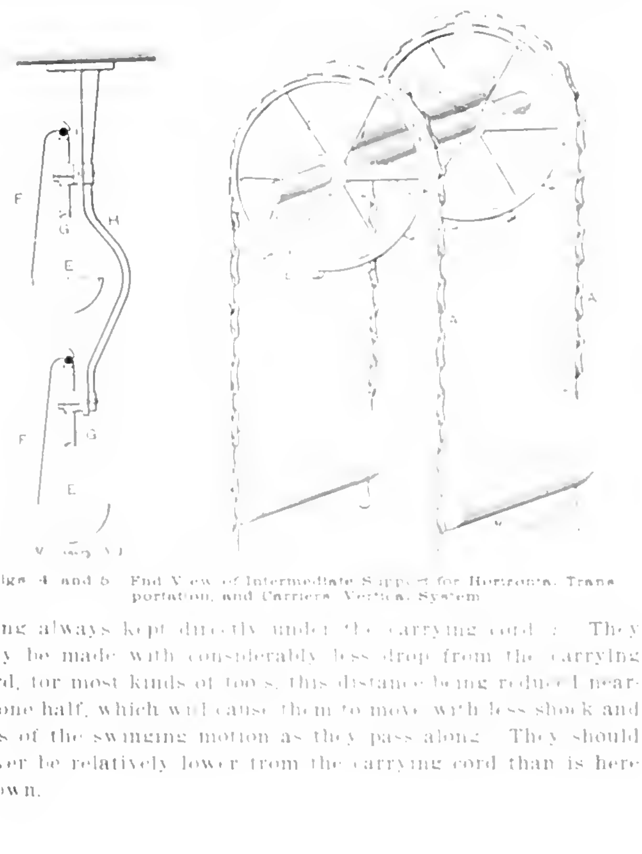
It is believed that the system herein shown and described, if properly constructed and installed, will fulfill all these conditions satisfactorily. In the engravings accompanying this article, Figs. 1, 2, 3, and 4, represent the system of horizontal transportation, and Fig. 5, that for vertical service. The horizontal system consists of a half-inch braided cotton sash cord, fitted with metal couplings and passing over comparatively large sheaves at each terminal. Upon this carrying cord are suspended hanging receptacles of suitable form and dimensions for holding the tools to be transported. Fig. 1 is a side elevation of the fixed terminal, the shaft *b*, upon which is fixed the main sheave *B*, being journaled in the hangers *A*, one of which is of sufficient length to furnish a bearing for the shaft, while the other has formed upon it a curved arm *a*, in the outer end of which is journaled the sheave *C*, for the purpose of supporting the carrying cord *d*, at the point where the carrier leaves the cord in coming to rest. Fixed to the extending arm *a* is an inverted U-shaped piece of sheet metal *D*, covering the carrying cord *d*, and furnishing a resting place for the carrier. This carrier is composed of a box *E*, of sheet or cast metal, with a curved bottom as shown, and suspended by the malleable iron supports *F F*. These are shown in end elevation, the supporting sheaves in section, in Fig. 4, which shows the supporting sheaves *G G* and the bracket *H*, on which they are journaled. This device is also shown in front elevation in Fig. 2. This supporting device should be located at suitable



Figs. 2 and 3. Intermediate Support and Adjustable Terminal Hanger of Horizontal System

distances along the line according to the loads to be carried but always near enough to each other to prevent undue shocks as the carriers pass over the supporting sheaves.

The carriers shown are of simple form and will be most useful for carrying the usual variety of small tools. Any convenient form may be used, however, the center of gravity



Figs. 4 and 5. End View of Intermediate Support for Horizontal Transportation, and Carriers Vertical System

being always kept directly under the carrying cord *d*. They may be made with considerably less drop from the carrying cord, for most kinds of tools, this distance being reduced nearly one half, which will cause them to move with less shock and less of the swinging motion as they pass along. They should never be relatively lower from the carrying cord than is here shown.

Fig. 3 shows the adjustable terminal hanger K, and its connections. In this case two hangers are cast on a plate L, or permanently fixed to it, one of them having a projecting arm k, carrying the supporting sheave P, and being provided with the U-shaped cord shield n, similar to that shown at D, Fig. 1. The plate L is arranged to slide upon the plate M, and is secured to it by two bolts as shown. The adjusting screw R is provided for taking up any slack that may be in the carrying cord d. The main sheave, J, is fixed upon the shaft j, which is journaled in the hangers K.

In operation, the device is driven from a pulley of suitable size on the shaft b, and at such a speed as will give sufficient momentum to the carrier E, to cause the carrier arms $F F$ to ride up on the whole length of the cord shields D and n, and stop there with very little shock, the carrying cord running in the direction of the arrows. In use the carriers have only to be taken off and hung upon the returning portion of the carrying cord to return the empty or loaded carrier. Upon the arrival of a carrier it glides up on the cord shield D or n, and remains there until removed. Should a second carrier arrive before this one is removed no harm is done, although it is expected that they will be removed as soon as they arrive. The cord shields $D\,n$ may be made long enough to accommodate two carriers, but this will seldom be found necessary.

The vertical system is shown in Fig. 5 and consists of two parallel chains $A\,A$, passing over the sprocket wheels $B\,B$ at the top and under similar ones at the bottom. These chains may be driven from either the upper or lower shaft as may be most convenient. Pivoted to these chains are the carriers $C\,C\,C$, which may be made of cast or sheet metal, and so formed, with the center of gravity considerably below the pivots, that they may always remain right side up, even when passing over the shaft b. These carriers should be about eight feet apart on the chains, and they should be painted a different color for each floor to which they are consigned, so that their contents may be readily removed at the proper destination without stopping the movement of the device for that purpose, it being understood that all descending carriers are consigned to the tool room on the first floor, or toward it, provided it is located on any other floor. These carriers may be so constructed as to automatically dump their contents at the proper floor without the attention of an attendant for that purpose. This system may be used in situations where continued vertical and horizontal transportation is wanted, by running the chains over gliding sprocket wheels at the proper turning points, as the carriers will always maintain their proper positions no matter what may be the direction of movement of the chains. However, for long horizontal distances this system will not be found as economical or as efficient as the first method described. The chain system should be run at a much slower speed than the cord system, as the carriers should be unloaded while in motion, while those on the cord system come to full stop until they are again wanted. Each will be found to be best adapted to its own particular sphere of usefulness as herein described.

AN ENGLISH HIGH-SPEED PLANER.

Our British friends seem to have been making considerable progress along lines of their own in the problem of designing high speed planers. The Bateman's Machine Tool Co., Ltd., of Leeds, England, have gotten out a line of patented high-speed planers, which carries several points of considerable interest. One of these machines, the 60-inch by 60-inch by 12-foot planer, here illustrated as Fig. 1, has a cutting speed of 40 to 45 feet per minute, and a return speed at 140 to 150 feet per minute, certainly a remarkable speed for a planer of its size. The rate of speed is correspondingly high on the smaller planers. On the 24-inch by 24-inch by 6-foot machines, the cutting speed can be arranged from 20 to 60 feet per minute or higher if required, with the return speed of 170 to 220 feet per minute. These high speeds are said to be characterized by very smooth running and the absence of any very great comparative absorption of power at the moment of reversal. These good points are largely produced by the patented features of the machine, the sliding rack and the flywheel loose pulleys for use with the overlapping belt, both shortly to be described.

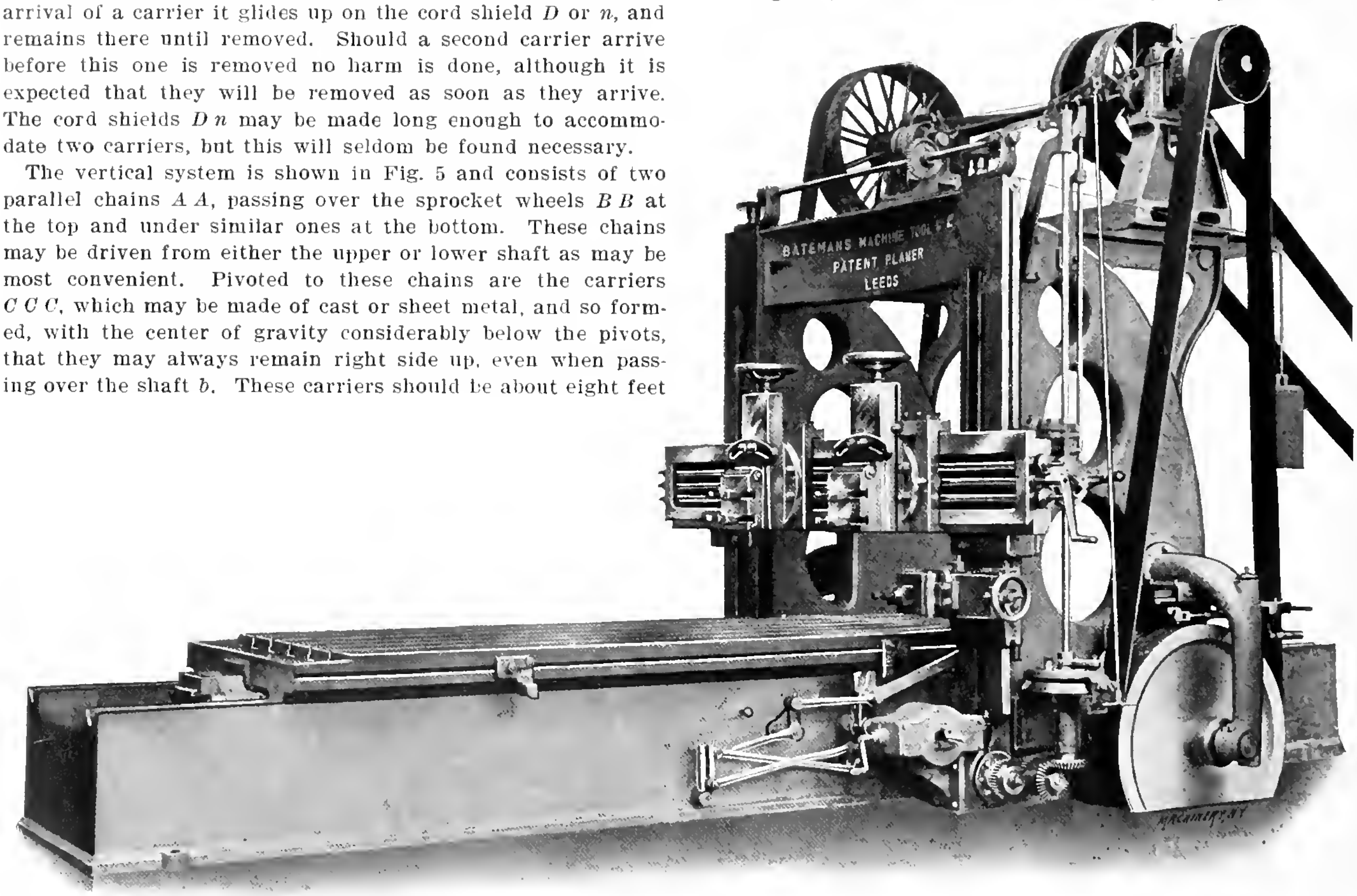


Fig. 1. Bateman's 60-inch x 60-inch x 12-foot Planer, Cutting at 45 feet per minute, and Returning at 150 feet per minute.

In the ordinary rack-driven planing machine, the rack is bolted direct to the table. In Bateman's planer a patented feature in the form of a sliding bar which has a short longitudinal motion in a groove in the under side of the table is introduced, and the rack is fixed to this bar. This arrangement is shown in Fig. 2, which gives a plan of the under side of the planer table. To a crosshead at one end of the sliding bar, spindles are secured, carrying adjustable springs. These springs absorb the shock of reversal and, being compressed, help the table to start in the new direction at reversal, relieving the belts of much of the extra strain to which they would otherwise be subjected. There are two sets of springs fitted underneath the table, one to absorb the reversal from return to cut and the other pair to absorb it from cut to return. If the springs are properly adjusted the table floats between them, and as soon as the cut is started one pair of springs tends to be compressed. The adjustment of this pair of springs can be so arranged that the pressure of the tool on the work brings the crosshead at the end of the rack in

direct connection with the end of the table. There is thus a metal to metal pressure, avoiding the possibility of any unevenness in the cut. The makers say, however, that they find it unnecessary to make this adjustment in many cases, especially if the cut is light.

The second patented feature making for smoothness in running is the use of flywheel loose pulleys, used with overlapping belt and automatic friction clutches between the flywheels and fast pulleys, there being one clutch on either side of the machine for cut and return. The operation of this device may be understood by the sectional view given in Fig. 3. The belts, being wider than the fast pulleys, overlap onto the flywheel pulleys when thrown over to do their share of the work, and through this overlap obtain much of the conserved energy of the flywheels at the moment when it is most required. The friction clutches further assist the fast pulleys in obtaining conserved energy from the flywheel loose pulleys.

The action of the clutch is briefly as follows: The rod *A* is actuated by the belt shifting devices and moves the vertical shaft *B*, which carries at its lower end a small pinion *D*.

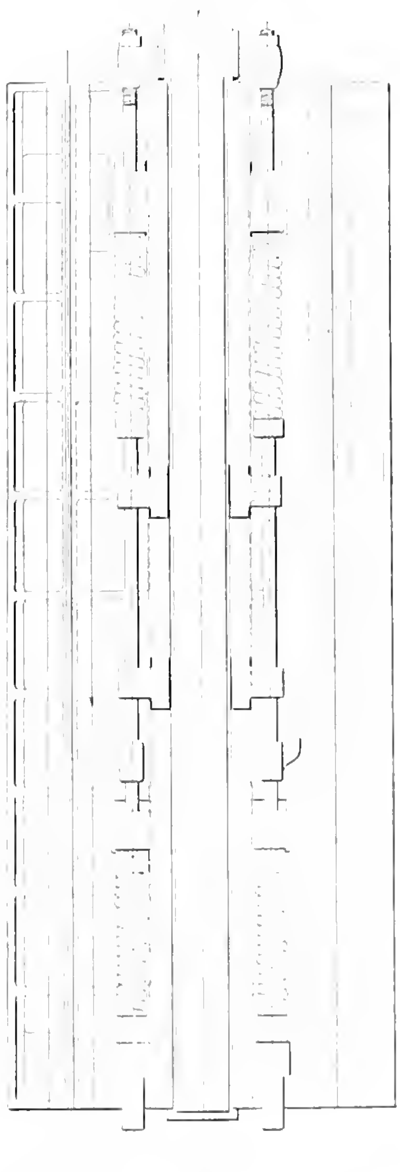


Fig. 2. Plan of Under-side of Table, showing Device for Absorbing Shock

This latter gears into a short rack cut on the slidable bushing *E*, the bushing being free to move along the pulley shaft *F*. Attached to the inner edge of the slide bush *E* are segments of the gripping ring *G*, working in a recess on the boss of the flywheel loose pulley *H*. A ball thrust bearing is provided between the end of the slide bush and of the boss of the flywheel pulley. This loose pulley *H*, as well as the slide bush, is free to move along its shaft. Any motion given to rod *A* by the shifting devices of the planer is, as is easily to be seen, transmitted to the flywheel, which is thereby moved so that the friction clutch *J* is either brought into or brought out of action. This motion is so timed as to take place when the belt is thrown on or off the fast pulley, and, together with an overlapping of the belt from the fixed on to the flywheel pulley, enables the conserved energy of the flywheel to be transmitted into the fixed pulley at the moment when most power is required as stated above.

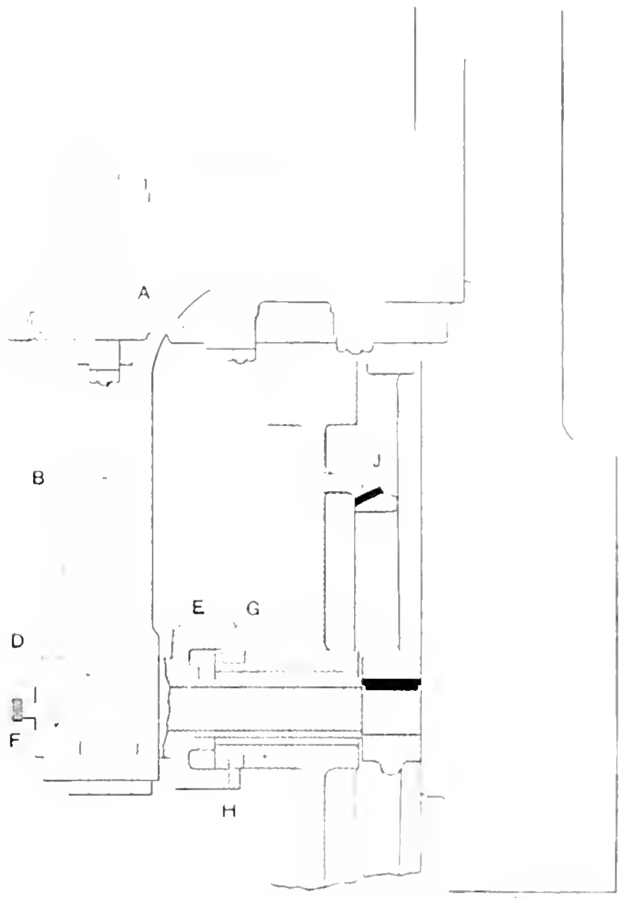


Fig. 3. Sectional View of Flywheel Loose Pulley, used with Overlapping Belt, and Automatic Friction Clutch

The beds of these planers are heavily designed and are of double box form without feet. They are unusually long, the run-over of the table consequently being very short. The tables are strongly webbed to counteract any tendency to buckle or distort. The housings are designed for great rigidity and are tied together at the top by a bridge piece. The cross rails are deep and can be raised and lowered by power as well as by hand on all except the smaller machines. The length of cross rail provides that where two tool heads are used, the near head can be traversed across the whole width between the housings independently of the off head. All planers of medium or large size are built to carry two tool heads on the cross rail and one side tool on the near housing and can be fitted with a side tool head on the off side if desired. The feeds for the cross rail tool heads are automatic and can be started, changed or stopped instantly while the machine is at work, and are actuated by a new friction arrangement through a vertical shaft carried on ball bearings. The vertical feeds on the side tool heads are actuated by the knocking-off arrangement. The high speed gearing is chiefly of cast steel and is lubricated in an oil bath, the other gearing is of cast iron, and all are specially broad on the tooth. The high speed shafts are of carbon steel and run in phosphor bronze bearings.

* * *

It is alleged that Dr. Hadfield has discovered an alloy of aluminum, copper and manganese which is nearly as magnetic as low-grade cast iron, although it contains no iron at all. The discovery is considered as being of importance, as it may throw considerable light upon the mystery of magnetism.

AN AUTOMATIC GEAR CUTTING MACHINE.

An automatic and universal gear cutting machine, having a number of new features, has been placed on the market by the Brown & Sharpe Manufacturing Co., Providence, R. I. The machine will cut spur and bevel gears of 12 inches diameter, 8 inches face, and 10 diametral pitch, if of cast iron, or 12 diametral pitch if of steel.

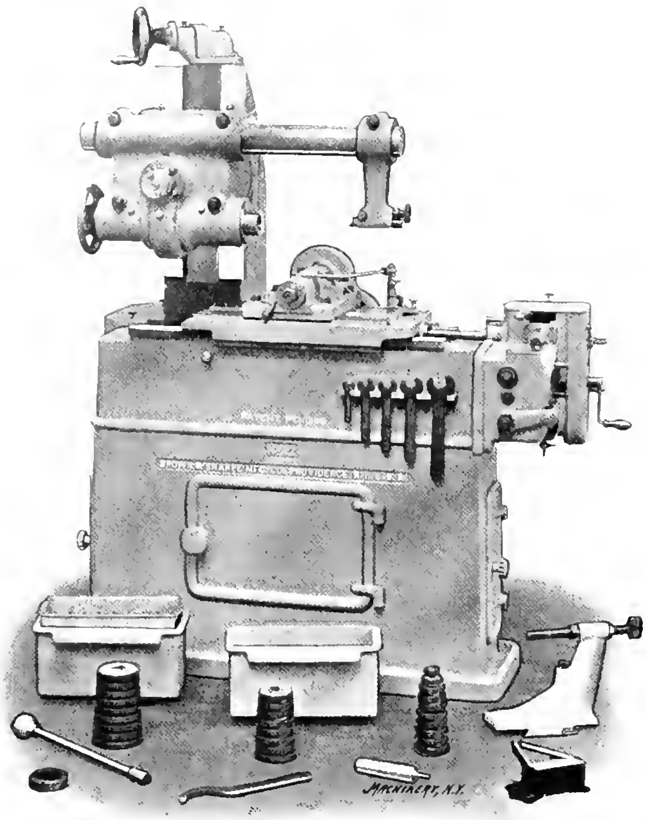


Fig. 1. Front View, Automatic Gear Cutting Machine.

Reference to the front and rear views, Figs. 1 and 2, shows the frame of the machine to resemble the type that has already been used by this company, but close inspection will reveal a number of important differences in the design of the working parts. First of all, the work spindle and the outer support for the work are carried by a swivel head, graduated to allow the spindle to be set to any angle or to be reversed in position, so that the work may be placed on either end of the spindle. The index wheel, apparently conspicuous for its absence, is encased within the head where it is protected from dirt and chips. In Fig. 2 it will be noticed that the drive for the cutter spindle is by means of sprockets and a silent

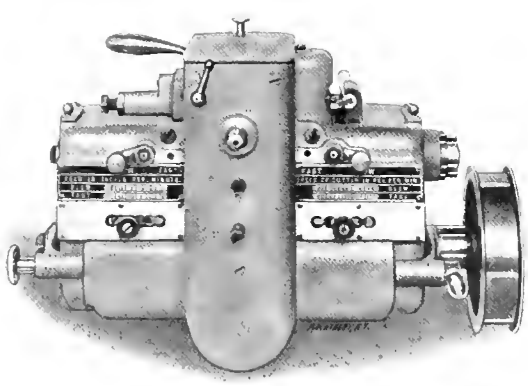


Fig. 3. Speed and Feed Gear Case.

chain. At the end of the machine is a large gear box, on one side of which is a single driving pulley which operates all of the different mechanisms of the machine. This pulley runs at a constant speed of 300 revolutions per minute and is driven by a $1\frac{1}{4}$-inch belt. The gear box contains two sets of cone gears for the feeds and speeds. Motion is also transmitted from this gear box to the quick-return mechanism and the indexing mechanism, which controls the working spindle.

The line engraving (Fig. 5) shows the section of the head which carries the work spindle and the upper part of the upright, upon which the head slides. Motion is transmitted to the work spindle from the shafts *M* and *N* and the dividing wheel *W*, in which a worm upon shaft *N* meshes. The head is adjustable on the machine upright and is controlled by means of an elevating screw which is operated by a hand wheel, the thrust being taken by ball bearings. A dial graduated to read to thousandths of an inch indicates the position of the head and facilitates setting the blank for depth of cut.

The head can be completely revolved about the axis of shaft *N* to allow the other end of the work spindle to be used, which adapts the machine to cutting all varieties of bevel gears. The head is graduated around its entire circumference to read

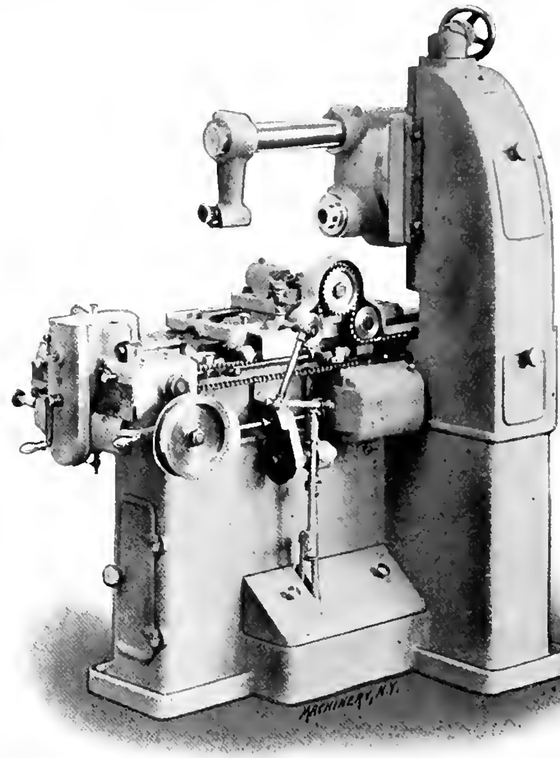


Fig. 2. Rear View of Machine.

to one-half degrees. Both ends of the spindle are provided with a No. 10 taper hole, and the advantage of being able to use either end of the spindle will be evident from Fig. 8, which shows a method of cutting a bevel gear on the end of a long arbor. The worm and wheel are not disengaged when adjusting the work; the worm is held to its bearing on the shaft by a friction cone and the locking screws *A* and *B*

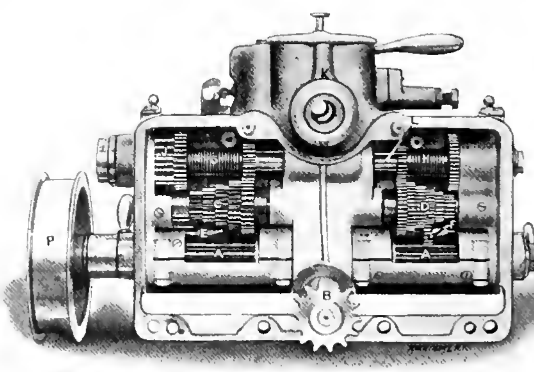


Fig. 4. Rear View of Case, showing Gears.

(Fig. 5) which, when loosened, permit the worm to be turned by the knurled knob, *C*. The base of this knob is graduated to read to thousandths. The hand wheel on the end of the work spindle serves to release a friction clutch and allow the spindle to be turned by hand when truing up the work An overhanging arm, *K*, Fig. 5, is clamped in the head and supports the outer end of the work spindle; while, in addition

to this, an adjustable rest is provided which can be fastened to the frame of the machine directly back of the rim of the gear in front of the cutter, and serves as a support when cutting spur gears.

In Figs. 3 and 4 are exterior and interior views of the case containing gearing to control the speed and feed of the cutter.

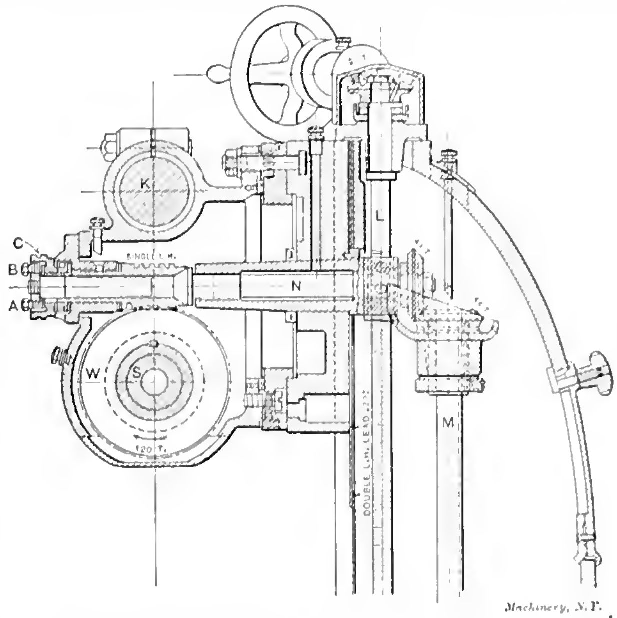


Fig. 5. Partial Vertical Section of Upright and Head.

The drive is through the pulley *P*, Fig. 4, and the shaft carrying the elongated pinions *A A*. The one of these at the left transmits motion to the sprocket wheel *J*, which drives the cutter by means of a silent chain; and the other to the shaft *L*, which drives the feed mechanism contained in the upper

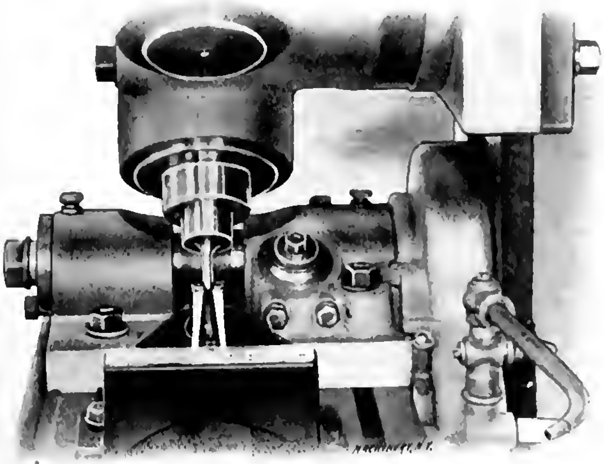


Fig. 6. Cutter Indicator in Position.

part of the casing at *K*. The speed and feed mechanisms, therefore, are entirely separate, and are operated from a constant speed shaft; and when the speed of the cutter is changed, the feed is in no way affected unless a change in the feed gearing is also made. The speed mechanism is a cone of five

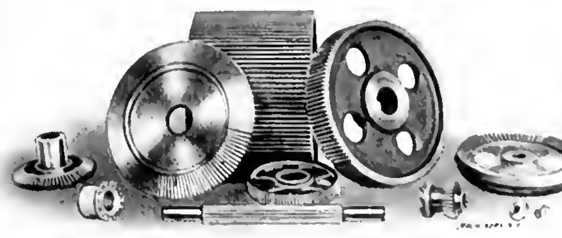


Fig. 7. Some of the Product, showing Capacity of Machine.

gears, *C*, driven through the pinion *A* from the sliding gear *E*. There is also a pair of back gears, doubling the number of speeds. These are attached to the sleeve *G*, which has annular grooves turned on it so that it may be moved longitudinally on its shaft by engagement with a small pinion operated by a handle in front of the casing, for the purpose of bringing either of the gears into mesh with the corresponding gears of the cone. The sliding gear *E* is operated by one of the knobs (also in front of the casing), together with a swinging handle shown at the right, near the pulley in Fig. 3. This combination produces 10 speeds, and the similar arrangement of feed gears produces 12 feeds, varying from ¾ inch to 5

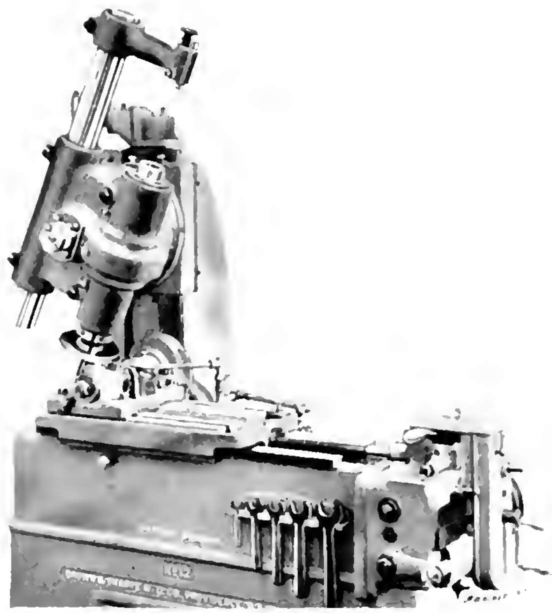


Fig. 8. Cutting Bevel Gear with Inside Hub by using Outer End of Work Spindle

inches per minute. The engraved plates on front of the gear casing show the speed and feed secured with any given set of mechanisms.

The quick-return motion is driven through a worm and worm wheel by the pulley shaft and a sprocket wheel on the same shaft with wheel *B*, Fig. 4, but at the other end of the shaft. A silent chain connects this sprocket wheel with an

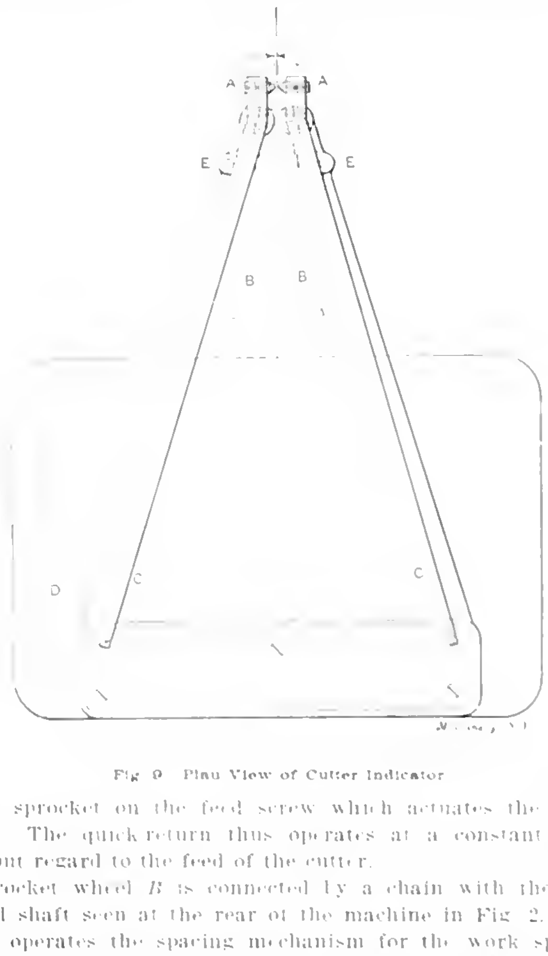


Fig. 9. Plan View of Cutter Indicator

other sprocket on the feed screw which actuates the cutter slide. The quick-return thus operates at a constant speed without regard to the feed of the cutter.

Sprocket wheel *B* is connected by a chain with the horizontal shaft seen at the rear of the machine in Fig. 2. This shaft operates the spacing mechanism for the work spindle, this mechanism being encased in the cast iron box appearing by the upright and just below the cutter slide in Fig. 2.

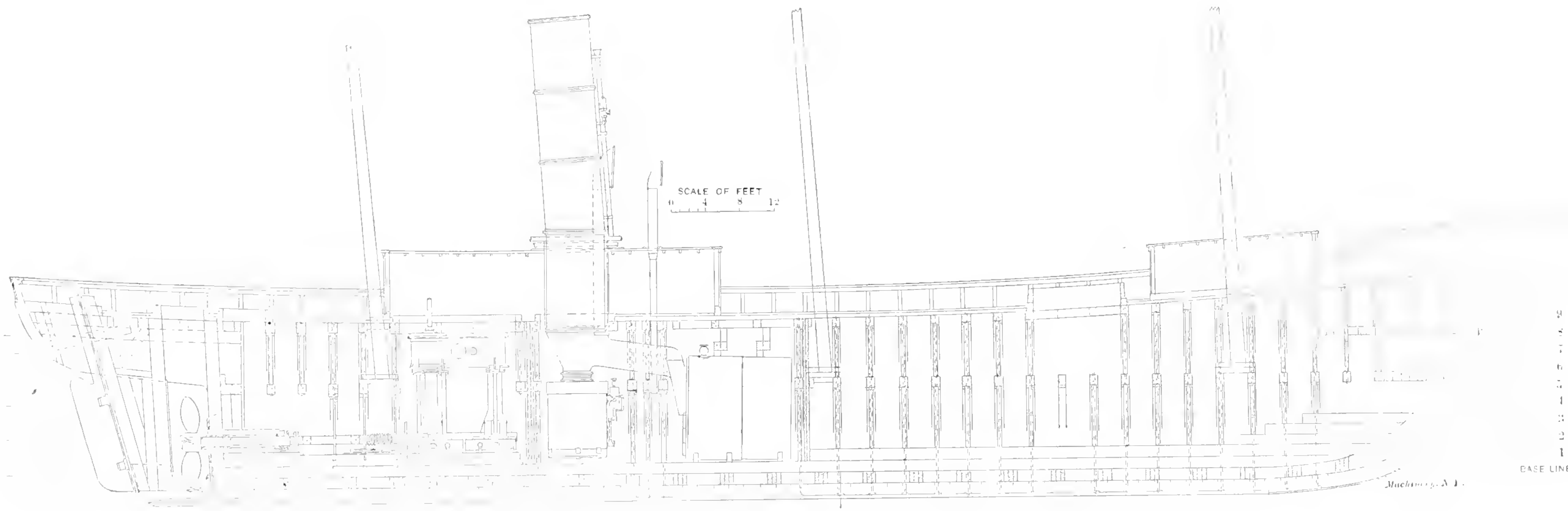


Fig. 2. Longitudinal Section of Hull, showing Heavy Bracing.

The index worm and wheel are entirely enclosed, and the spacing mechanism provides for the cutting of all numbers of spurs or bevels from 12 to 50, and of all numbers from 50 to 400, except prime numbers and multiples. The change gears in the indexing mechanism all have clutches to attach them to their shafts, no keys being used owing to their liability of working loose and creating errors in the indexing.

An indicator for setting the cutter centrally with the work is provided, as shown in position with the test center in the work spindle, in Fig. 6. This indicator, shown in plan view in Fig. 9, consists of two swinging arms and a cast iron base made in box form and sufficiently heavy to hold the indicator in place without clamping. Referring to Fig. 9, the arms *C-C* swing about bearings, *A-A* being the measuring points, which can be adjusted to compensate for wear. The measuring surfaces are held in contact with the cutter, when the latter is being adjusted, by the two flat springs shown at *B*. Stop pins *E-E* prevent the arms from swinging too far apart. The tongue *D*, on the bottom of the base, fits into the outer T slot on the cutter carriage.

* * *

THE MACHINERY AND HULL OF PEARY'S NEW ARCTIC SHIP.

Lieutenant Peary, the famous Arctic explorer, is to start on another expedition this summer in search of the North Pole. He and his party will go in the steamship Roosevelt, a new vessel that has been built in Maine expressly for this voyage. The hull of the vessel is of oak heavily braced by oak and hard pine timbers, and through the courtesy of Mr. H. K. Griggs, Portland, Me., we are able to show a number of views of the hull and machinery. The hull was built by McKey & Dicks, Buckport, Me., and the machinery by The Portland Company's works, Portland, Me.

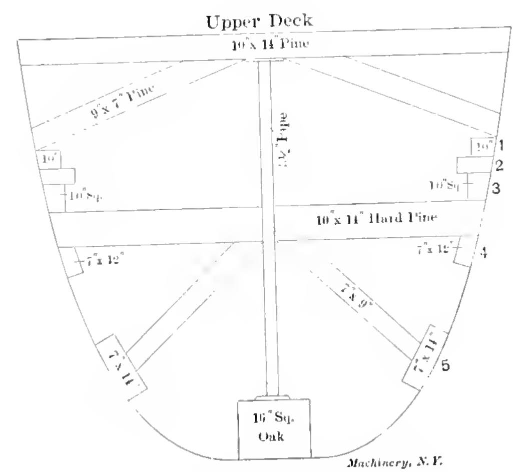


Fig. 1. Section Amidships, showing Dimensions of Braces used in Hull.

The ship is 180 feet long, 32 feet beam, and has three masts, being rigged as a three-masted schooner. She will ordinarily proceed under sail, but the auxiliary steam power may be used as required either to hasten the rate of speed or to force the vessel through the ice floes of the North. Unlike most ships with auxiliary power, however, the engine power is great enough to enable the vessel to proceed under steam at a good rate of speed, and not depend upon her sails, if such a course should be necessary or desirable. A general view of the hull in Fig. 3 was taken before the vessel was launched and shows Lieutenant Peary standing in the foreground. Fig. 2 is a longitudinal section of the hull, indicating the location of the boilers and machinery, and showing the large number of cross and longitudinal braces that are used to strengthen the hull, these braces being additional to the usual framing employed in the hulls of ships of this size.

In the midship section, Fig. 1 is an outline of the arrangement of the bracing with the sizes of the timbers given, thus affording an idea of the enormously heavy construction used for the purpose of resisting the pressure that the hull is likely to be subjected to when in the ice. Cross braces start at the bow and extend aft as far as the boilers, being spaced about 3 feet apart. The keel is of 16-inch square oak and the timber used to brace the bow is of 16 x 24-inch oak. Outside of the

bow, in the vicinity of the water line, there is an extra thickness of 3-inch planking, which is covered with ½-inch boiler plate. Ordinarily little or no bracing is used inside of the hull of a ship except the framing, so that it will be seen to how great an extent the hull of this boat is reinforced.

The main engine is of the usual compound marine type of about 1,400 H. P. The cylinders are 24 and 52 inches in diameter and 30 inches stroke. The shaft is 12 inches in diameter and carries a propeller 8 feet in diameter, [illegible] blades. The propeller has a cast steel head with [illegible] blades bolted to it. Provision is made for removing the blades, since two-bladed propellers are considered safer and more effective for ice breaking. Steam is generated in the single Scotch boiler 10 feet in diameter and 12 feet long with three furnaces, and two Almy watertube boilers. The view Fig. 5 shows the Scotch boiler being placed in position.

Fig. 3. Hull of S S Roosevelt, Peary's New Arctic Ship. Peary Standing in the Foreground

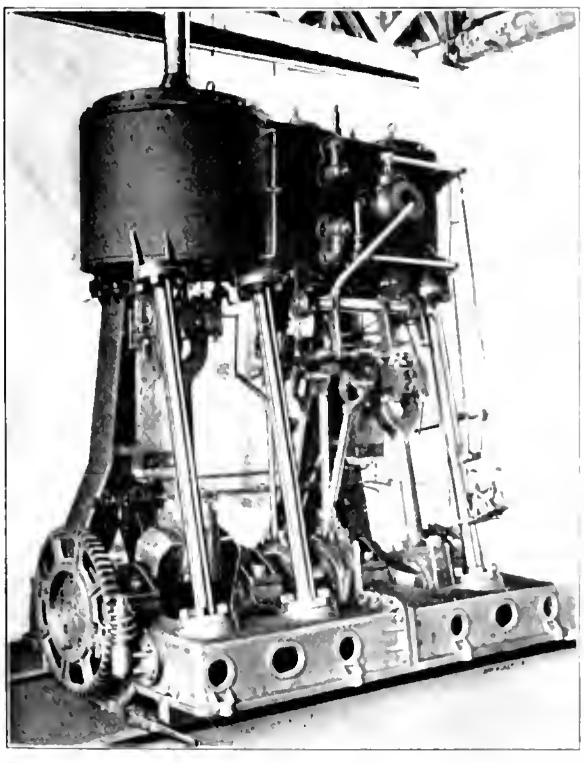


Fig. 4. Engines of 1400 Horse Power used to Propel the Steamship

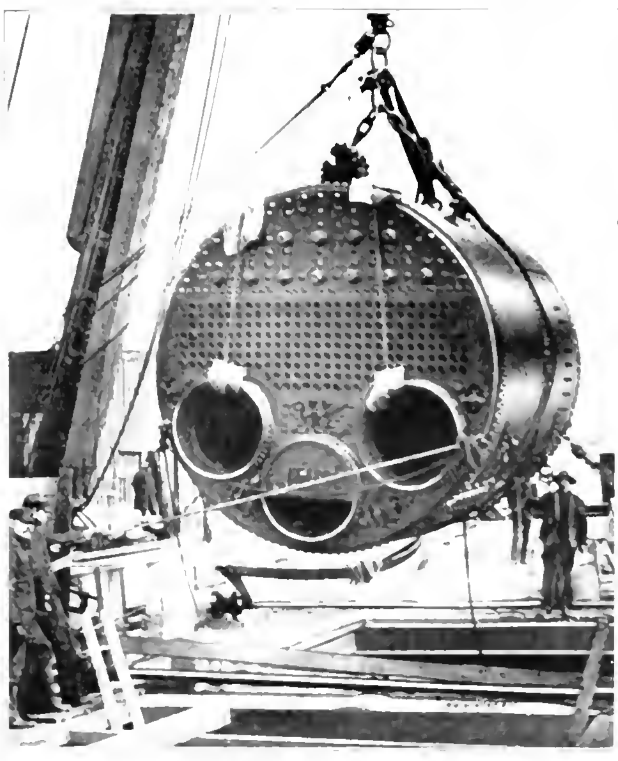


Fig. 5. Lowering one of the Boilers into the Hold

GANG MILLING OF REPETITION CASTINGS.

JOSEPH V. WOODWORTH.

In the manufacturing of small interchangeable castings for machine parts, gang milling fixtures play a very important part. When the parts are machined to extremely accurate dimensions, and are produced under the modern piece-work system, the object sought is to handle as many castings at a time as possible, in fixtures so designed as to insure the complete interchangeability of the product.

To illustrate the value of gang milling fixtures for manufacturing accurately machined duplicate parts, and also how a number of such parts may be handled and machined expeditiously at the minimum of cost, I describe in this article a gang milling fixture which is in use in an establishment requiring over 100,000 of the castings machined in this fixture per year.

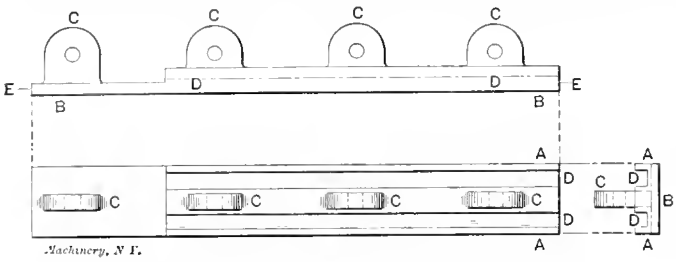
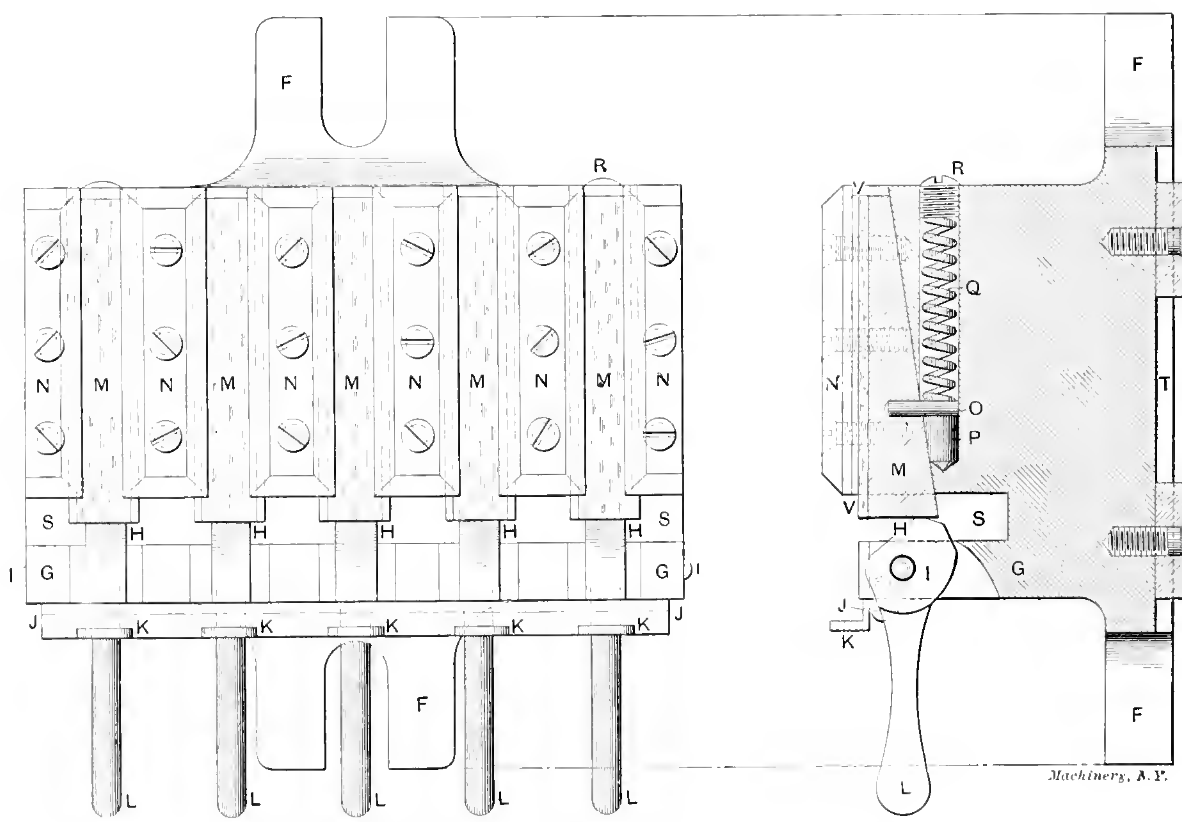


Fig. 1. Casting Machined in Gang Milling Fixture.

In Fig. 1 we have three views of the casting machined in the fixture. The work performed is the milling of the two channels indicated by *D*. Previous to this operation the casting is machined on the back *B* and also on the sides and ends *A* and *E* to limit gage measurements. Subsequent to the operation, the four holes *C* are drilled in the projecting lugs, the insides of the channels being utilized as banking or abutment surfaces for the locating of the castings in the drilling jig. Figs. 2 and 3 are two views of the fixture complete, Fig. 2 being the plan view, which shows the appearance of the fixture without the work in it, and Fig. 3 a vertical cross-sectional view. Fig. 4 is a longitudinal sectional view of the fixture, and also of the gang of ten cutters used in conjunction with it. *Y* represents the cutters; *X* represents the washers or collars; and *W* represents the milling machine spindle. Fig. 5 is an end view illustrating the fixture with the work in position and presented to the cutters for milling.

The fixture handles five castings at a time. The body casting has projections or wings at two sides *F*, and has platen locating tongues at *U*, for fastening and locating it in the platen. The body casting has five inclined channels milled in its face to accommodate the five hardened tool steel work locators *M*. The five parts *N* are also of tool steel, hardened and tempered, and fastened to the wall surfaces between the inclined channels by means of three flat-headed screws each. These pieces serve as banking pieces or surfaces for the work to clamp up against. Five eccentric levers *L* force the work locators up the inclined ways, thus clamping the work in position against the plates *N*. These levers are fastened in milled slots by means of the drill-rod shaft *I*. The eccentric portions of the levers are indicated clearly at *H* in Figs. 3 and 5. *J* is a stop bracket fastened to the back of the fixture or body casting by means of several round head screws. The portions at *K* are stops against which the ends of the castings, to be machined, abut. The construction for forcing the work holders back in the inclined channels upon the releasing of the eccentric clamping levers *L*, thus allowing of the removal of the work, is shown in the vertical sectional view, Fig. 3. It consists of a stiff spiral spring *Q*, located in the drilled hole *P*, a pin *O* for engaging this spring, and the headless setscrew *R*. One end of the spiral spring rests against the screw *R*, and the other against the pin *P*. The tension is kept sufficiently stiff to cause the work-holders to release the work immediately upon the lever *L* being pulled upward; each of the five work holders is equipped with such an arrangement.

When in use the fixture is clamped to the platen of a large universal miller and the table adjusted until the work receivers or holders are in the relative positions to the cutters illustrated in Figs. 4 and 5. The castings are located in the holders; the eccentric levers are pushed downward, as shown in Fig. 5; and the castings are thus clamped in position. The feed is then thrown in and the platen and fixture travel forward until the channels *D* and *E* are milled. The table is then fed backward and the machined work removed.



Figs. 2 and 3. Plan and Vertical Cross-sectional Views of Complete Fixture.

* * *

An English newspaper, the *South Bucks Standard*, tells how a bicycle ball stopped a train: "Recently, as a train was running at high speed on the Great Eastern Railway, the engineer felt that there was something wrong with one of the wheels of the engine. On making an examination he found that a ball of a bicycle bearing had become fixed in the outer surface. The ball was so firmly embedded in the steel that it could not be extracted."

MULTI-STAGE CENTRIFUGAL PUMPS FOR ELEVATOR SERVICE.

An interesting application of multi-stage centrifugal pumps has recently been made in a new and very complete power installation in the building of the John Taylor Dry Goods Co., Kansas City, Mo., and affords another example of the prevailing tendency to use pumps of this type where reciprocating pumps would have been thought necessary only a few years ago.

Three of these pumps were installed for operating the hydraulic elevators of the building under a pressure of 110 pounds per square inch. They are direct-connected to electric motors, receiving their current from generating units comprising part of the power plant of the building. The motors are under the control of Cutler-Hammer automatic controllers mounted on panels and assembled uniformly with the panels of the main switchboard.

The three pumps supply the water for the complete hydraulic system upon which all the hydraulic elevators of the store are connected. The elevators are separated widely over the premises, in some cases nearly a city block apart.

The arrangement of the piping is unique. There is one pressure main from the discharge openings of the pumps, which runs throughout the whole building past each of the elevator machines. This pressure main is connected into a compression tank in each end of the building, the two tanks being set at the same level and carrying their water lines at the same height. The connection for each elevator machine is then taken from this main at a convenient point. There is a discharge or return main paralleling the pressure main into which each elevator machine discharges, and this return main is connected to each of two open, or "surge," tanks located near the compression tanks, and then continues on and connects to the suctions of the pumps. With a suitable arrangement for "snifting" entrained air out of this suction line the operation of this system is perfect.

The capacities of the pumps were chosen to fit the service requirements at all times, throughout the variations of load during a day's run, while at the same time providing a reserve capacity for accidents or contingencies. Two of the pumps have a capacity of 300 gallons a minute and the third one a capacity of 500 gallons a minute. By this arrangement it is possible to secure 300, 500, 600, 800 or 1,100 gallons a minute as required. All that is required for the heaviest service at the present time, however, is 800 gallons per minute, so that with either of the smaller pumps out of service all the elevators can be operated at full capacity, and if the largest pump should break down, 600 gallons a minute would still be available, and would amount to a reduction in capacity of only 25 per cent.

The type of pump was selected from considerations of economy, noiseless operation and great compactness, all of which were very essential in this instance. No reciprocating pump could have been installed in the given space that would have had the requisite capacity with anything approaching the degree of economy guaranteed by the makers of these multi-stage pumps. The importance of compactness will be evident

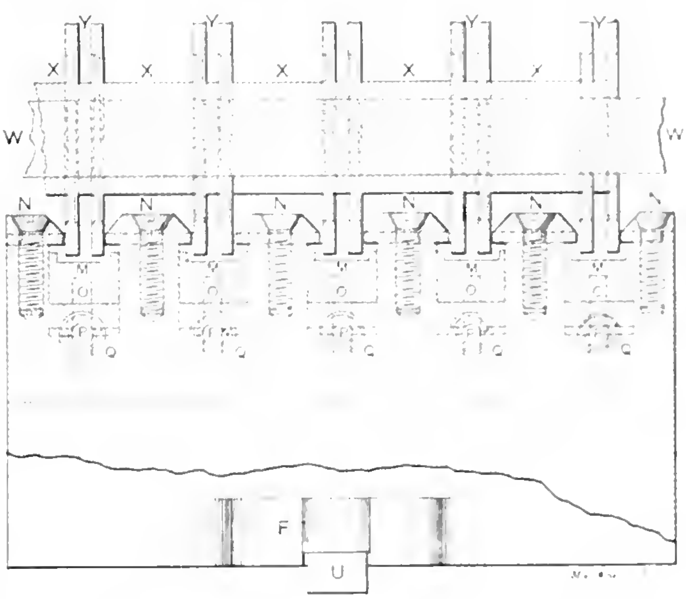


Fig. 4. Longitudinal Section of Fixture and Gang of Cutters

when it is stated that this installation is two floors below the ground floor, in a sub-basement in which there are many building columns and other obstructions. The engineers were not satisfied to install centrifugal pumps, however, until a careful test had been made; and they went to Atlanta, Ga., and tested a similar pump which operates the elevators in the Equitable building of that city, with satisfactory results. The pumps at Kansas City are similar to this one, but have the added feature of the Cutler-Hammer controlling apparatus, which automatically starts and stops the pumps to meet the service conditions.

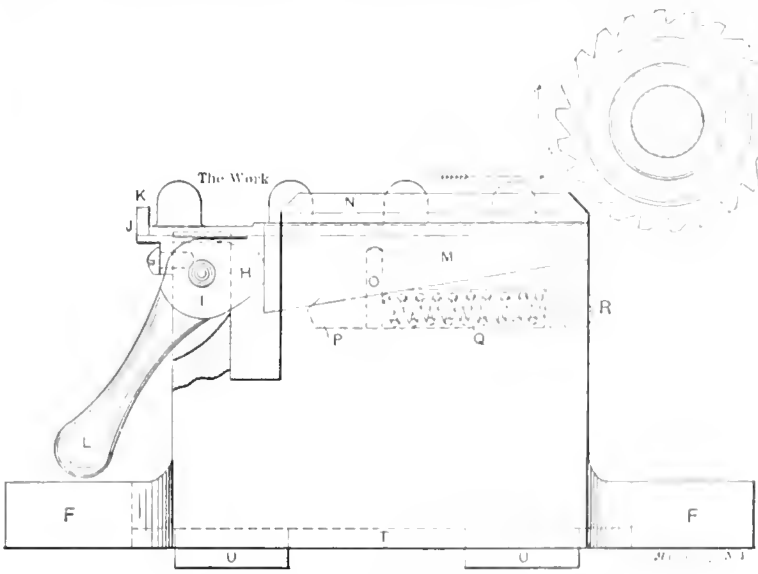


Fig. 5. End View of Fixture with Work in Position

The nature of the turbine pump is such that a control device is not required except from considerations of economy. The pumps will automatically cease to discharge when the maximum pressure of the system is reached and the current consumption of their motors will fall to that required to merely rotate the mass of water in the impeller chambers. When the pressure is reduced discharge begins and the current increases proportionately to the amount of pumping done. Consequently, the pumps will operate entirely automatically without any special controlling apparatus, which is greatly in their favor, but the addition of the Cutler-Hammer controlling mechanism is considered a step toward greater economy.

The plant was designed and its construction superintended by W. K. Palmer, consulting engineer, Kansas City, to whom we are indebted for the foregoing information, and the pumps were supplied by the Worthington works of the International Steam Pump Co., New York.

* * *

The flexible staybolt problem is attracting much attention in railroad circles and many meritorious devices have been brought before the public to reduce staybolt breakage. The boldest scheme we have yet seen is that of an inventor who proposed to replace the ordinary staybolt by a substitute consisting of two eyebolts connected by a link. One eyebolt is screwed into the inner sheet and riveted over in the usual manner, but the other eyebolt is made with a large collar and is provided with a cap and nut. The cap is to cover a hole large enough for a man's hand, each staybolt hole being made thereby a handhole. While there can be but little doubt of the flexibility of the connection, it is open to the serious objection that in locomotive construction with staybolts placed as closely as is the usual practice, the handholes would cut out a large percentage of the outside plate, making it resemble the flue sheet rather than the ordinary boiler side sheet.

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HOW MUCH DOES IT COST?

We publish this month a contribution upon estimating the cost to manufacture a small machine. While the amount of labor and material required to produce the parts of this particular machine is of no practical importance in itself, we consider the article of unusual value to the average machinist because it points out the method of procedure in making estimates upon machine work.

Ask a machinist at the lathe how long it will take to turn out a certain piece of work, or how much he would judge the piece to be worth, and in the majority of cases his reply will be wide of the mark. It is commonly said, and is probably true, that few machinists are able to make even approximately correct estimates of the cost of machine work. The reason for this is that the man who is regularly employed in performing routine duties seldom attempts to analyze his work or to observe how long a time the different operations require. He is content to perform his work in a mechanical way.

No written article can teach such a person the science of estimating. All that can be done is to show the method to be followed, and then the facts, data and conclusions must be derived through observation and experience by the person himself. In this article upon estimating, the author has pointed out the course of procedure and the reader must gather his own information according to the kind of work that he wishes to make estimates upon. We commend to all young mechanics who expect to rise above the position of an operative, the practice of observing and of accumulating data upon the cost of machine work. The time may come when the ability to form correct estimates of cost may mean promotion to a better position.

* * *

THE ETHICS OF CONTRIBUTIONS.

When a farmer "trades" a tub of butter at the local grocery, or a machine tool builder sells a lathe to the X Y Z Manufacturing Co., both part with their property and receive its supposed equivalent, in some form, but neither would sanely expect to sell the identical tub of butter, or the same lathe, to another customer. In the very nature of things, the carrying out of a multiple exchange of this order, or any attempt at it, would brand one as dishonest or crazy. Unfortunately, the same condition *per se* does not apply to selling the wares of a writer, but the ethics of contributing to publications *for pay* are the same. Why then, we wish to ask certain of our contributors, do you think that you can honestly send your contributions to MACHINERY, and to two or three other trade papers, and receive payment from each? You cannot, but nevertheless we have been put to considerable trouble of late by receiving contributions which were sent to us and in duplicate or triplicate to other papers, and the only excuse for the authors that we can imagine is that of ignorance. It is said that Myra Kelly sent her first contribution on East Side life in New York to both *McClure's* and the *Century* magazines, and when she found that the story had been accepted by both publications, she was, as you say, "in a pickle." On learning something of the rules governing contributions she also incidentally found out that there is a law designed to protect publishers from actions of this character, but of course no editor would prosecute an ignorant offender, although he might be severely tempted to make some unprintable remarks about the contributor's common sense. The sum and substance of the above scolding is, that when you offer your written wares to MACHINERY do not try to sell them to other customers until you know that we have rejected them.

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VARIABLE SPEED MOTORS.

There is undoubtedly a general impression abroad that the usual speed range of an ordinary variable speed field-controlled electric motor is only about 2 to 1. In several articles published in recent issues of MACHINERY, this idea has been expressed, and correctly so, we believe, as regards the large majority of such motors. But, in justice to at least one concern, the Northern Electrical Manufacturing Company, Madison, Wis., it should be here stated that this limitation does not apply to the motors built by this company, inasmuch as while they are of the "ordinary" type they are made in variable speed ratios of 2 to 1, 3 to 1, 4 to 1, 5 to 1, and even 6 to 1. But, of course, the greater the speed variation the larger and heavier the motor for the same power output. For instance, a 10 H. P. Northern motor for continuous service, having a minimum and maximum speed of 650 and 1,300 R. P. M. weighs 1,235 pounds; when the speed variation is increased to 5 to 1, the same frame is required for a 4 H. P. motor. In other words, the greater the speed variation of any ordinary field-controlled motor for a certain power output, the greater must be the size of the motor. The same applies to a steam engine or any other mover in general; the engine which is required to deliver 100 H. P. to the line-shaft at 100 revolutions per minute must be practically twice as heavy as another which delivers 100 H. P. at 200 revolutions per minute. There is no doubt a great deal to be learned regarding electric motor construction, and no one in the present state of the art is prepared to predict just what changes will be brought about; but, in general, it may be said that this limitation must always apply—in a motor of the ordinary type—that the greater the speed variation the larger, heavier and more expensive must it be. It would, perhaps, be possible to build a variable speed motor which by field control alone would give a speed variation of 20 to 1; but its size and cost under the present conditions of building motors would be prohibitive.

* * *

The United States Consul at Prague, Austria, has had the enterprise to distribute a typewritten circular, and printed index cards for the purpose of securing data relative to manufacturers in this country and to their products, which he can have on file, at the consulate, for immediate reference, when inquiries are received by him. The index cards are called "Little Drummer" record cards, and to show their utility the circular gives the following rather concise and direct example:

"Mr. Buyer desires—well, say, automobiles. He addresses himself to this consulate; we have complete commercial data. He wants information immediately; we can furnish it immediately. We simply direct him to our "Merchandise File," which indicates to him the dealers, introduces the "Little Drummer" record cards, and drives in immediate sales. The information is most complete; he can cable an order immediately."

Mr. Ledoux, the consul, deserves much credit for his enterprise and should be backed up by those receiving the cards, to enable him to more completely carry out his mission as he sees it.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

A recent report from Consul H. W. Harris, Mannheim, Germany, says that a newly-invented German typewriting machine is described in the German press. It is said to print syllables and short words instead of single letters, attains much greater speed than others, and, it is claimed, will revolutionize the art of typewriting. So far as can be ascertained the machine is not yet on the market. A leading newspaper comments that when it is remembered how many millions from Germany and all Europe have gone to America for typewriter supplies the new product of German invention will be greeted with satisfaction.

An extensive use of diamonds is made for dies for drawing wire of the smaller sizes, up to, say .025 inch in diameter. Diamonds are used for this work because the wear upon the hardest steel dies enlarges the hole in the die to such an extent that the diameter of the wire is not uniform from beginning to end of the drawing. With diamond dies it is practicable to draw platinum wire to a diameter of .0005 of an inch. The diamonds used for this work weigh from four to five carats each and cost from fifteen to twenty dollars per carat. It is said that several hundred thousand dollars' worth of diamonds are used as dies in the various wire factories in this country alone.

The U. S. Consul-General at Frankfort, Germany, refers in a recent consular report to an address delivered by Professor F. Linde before the Technical Society of Frankfort in which a process for making oxygen from liquid air was described. If liquid air is allowed to evaporate slowly, nitrogen evaporates first and then the oxygen; the liquid remaining after evaporation has proceeded for a certain length of time, therefore, contains a higher percentage of oxygen than the normal proportion. By repeating the process a liquid is obtained which contains about 71 per cent of the oxygen of the air, and rectification permits of a further increase of the percentage of oxygen. The cost of production of oxygen by the Linde process is said to be one cent for thirty-three cubic feet. A supplementary process makes it possible to obtain pure nitrogen from the atmosphere.

In an interesting paper on motor drive as applied to cotton mills, read by Mr. Meldon H. Merrill before the annual meeting of The New England Cotton Manufacturers' Association held at Boston, Mass., April 26-27, the author made out a very strong case as showing the relative economy of direct electric motor driving applied to textile machinery over the group driving system. As an example he quoted the spinning room in one of the large New England mills in which a 200- H. P. motor operates 52 ring spinning frames. The cost of the installation was $2,694.00, of which $2,060.00 is represented by the motor and $634.00 by the cost of belts and shafting. If these machines were direct connected to electric motors, 52 three-horse power motors would be required at a cost of $5,260, leaving a difference of $2,566 in favor of group drive. The interest on this amount at 5 per cent, would be $128.00 a year; but it was found from actual tests at the above mill that 37½ horse power was required to drive the shaft load, no frames being in operation. Taking into account the difference in efficiency of the large and small motors, this means that 18 horse power is saved by using the direct-connected motors, which figure at $25.00 per horse power per year amounts to $450.00 and which compared with $128.00, the interest on the increased investment, shows a saving of $322.00 a year as the result of direct-connected drive.

Consul-General W. R. Holloway at Halifax, Nova Scotia, says that the steel bridge now under construction over the St. Lawrence River at Quebec is a remarkable structure. The weight of this bridge will be about 35,000 tons. Its span of 1,800 feet crosses the entire St. Lawrence River at such a height as not to interfere with navigation, and will be the longest in the world, the Forth bridge in Scotland being 1,710 feet long, the Brooklyn bridge 1,680 feet, and the new East River bridge in New York 1,600 feet. There have been manufactured by the Phœnix Bridge Company, Phœnixville, Pa., to date, and partly shipped to the site of the bridge, about 10,000 tons of steel. It will take about two more years to complete the structure. The masonry piers are entirely finished, and the temporary false works, of steel, are now in place on the south shore, upon which erection will begin at the opening of spring this year. The 1,800 feet of steel-bridge work between the piers will be erected without any false work in the river. The bridge is to be 80 feet wide over all, carrying a double-track railroad, a double-track trolley and highway and two sidewalks. Many novel features have been adopted in the design and manufacture of this bridge. The total length of the bridge will be 3,300 feet; length of channel span, 1,800 feet, ship clear headway, 150 feet above highest tide, height of cantilever towers, 360 feet above the river. The Phœnix Bridge Company are the contractors for the superstructure.

Electric welding by the well-known Thomson process is an American invention that is apparently attracting renewed attention in England, says the *Western Electrician*. A writer in the *Times* (London) notes that in many industries the system has caused a complete modification of existing methods of manufacture, and in some cases electric welding has created entirely new manufactures. The process is used for welding tramway rails, in the manufacture of steel chains, in the production of wire fencing and in the making of bolts, printers' chases, steel tubing, tires, hoops for casks, vehicle frames and many other articles. Electric welding has advantages which render practicable many operations which are impossible by the ordinary forge or gas blowpipe. Finished work may be welded and repaired without damage. The welding operation can be closely watched as it proceeds and faulty welds prevented. Welds are made with great rapidity, occupying only a few seconds, and in small work they are performed almost instantaneously. Impurities are excluded from the joint and a perfectly homogeneous weld is obtained. The results of tests of the comparative strength of electric and hand welds carried out for the late Sir Frederick Bramwell, show that whereas in the case of hand-welded iron bars the ratio of weld to solid was 89.3 per cent., in the case of electrically welded bars the ratio was 91.9 per cent. The cost of fuel is, generally speaking, about the same for hand and electric welding, but with the electric process the labor is greatly reduced.

The tendency in the construction of large modern power plants is to concentrate everything under one roof; hence we have 50,000 and even 100,000 H. P. plants for the generation of electric power for railway operation. The supposed reason for concentration is economy, but there is undoubtedly a limit beyond which the mere aggregation of units ceases to show any additional economy. When a plant has reached such a size that the chief engineer needs two or three assistant head engineers to see that the machinery is being properly looked after and coal efficiently burned then that plant has exceeded the economical limit. In other words there is no gain in economy in building a power plant, all other things being equal, which exceeds in size that which one chief engineer can look after and keep personally in touch with all the employees therein. This point was brought out very clearly by Mr. George I. Rockwood in a paper on boiler plants read before the Boston meeting, April 26-27, of The New England Cotton Manufacturers' Association. Mr. Rockwood said that in order for one chief engineer to watch attentively the daily routine of the large power and boiler plant, it should be compact and of such shape and dimensions that the engineer can easily see

and speak to every fireman, coal passer and oiler without moving about much himself. The limit to a size of a boiler plant which one man can properly oversee in this way may be placed at something over 5,000 boiler H. P. Obviously no labor is saved by concentrating into one unit a larger plant than can be carefully attended to by a single engineer. This fact seems to have been overlooked completely by designers of the great metropolitan electric stations.

U. S. Consul Richard Guenther, at Frankfort, Germany, refers in a recent report to the German fear of publicity and particularly to a circular letter issued by the Chamber of Commerce of Sorau, Prussia, which was addressed to manufacturers and selling agents of that district. The letter is a remarkable plea for secrecy, advising manufacturers and agents to abstain from giving publicity to any details regarding their products except to those interested as customers. It urged that factories should be closed to foreigners or strangers and that all employes should be admonished to give nothing to newspapers or trade papers for publication. Mr. Guenther very properly closes with the following query:

"How do these German chambers of commerce, which represent the manufacturing and commercial elements of their country, reconcile this illiberal spirit with the fact that Germany sends individuals, official delegates, and even ministers of state to the United States to inspect our factories, trade schools, public institutions, etc., for the purpose of obtaining knowledge and benefitting German interests?"

PROTECTIVE DEVICES IN SHOPS.

Every year persons are killed or badly hurt in shops or factories by getting caught in moving machinery. It is, of course, practically impossible to prevent all accidents of this character, although a large proportion of them could be avoided by simple protective devices which cost very little, and give protection out of all measure to their cost. Our attention has been called to the danger that exists in many shops in the unprotected bars of stock running in turret lathes, by a distressing accident that occurred not long ago in a western machine shop. A long 2-inch bar with a rough crop end, was running in the machine, the outer part being held in the usual supports without a guard. A workman attempted to pass through the narrow space between the stock and a post with his back to the bar when the rough revolving end caught his jacket and threw him heavily to the floor, breaking his neck. While such accidents are very rare, there is a possibility of their occurrence wherever screw machine stock is running unprotected. It is a case where a simple pipe guard is not only a safety feature but an improvement in the support for long stock. A short opening between the end of the stock and the end of the pipe permits the stock to be manipulated, and so makes very little or no inconvenience. In the case of change gears for lathes, the danger of accident to life or limb is ever present if the gears are unprotected, and, from a merely selfish point of view on the part of owners, it is wise to cover such gears as they are liable to be broken by something else besides flesh and bone getting between them.

THE IMPORTANCE OF HAVING THE ENGINES OF TWIN-SCREW SHIPS WORK IN UNISON.

In the June, 1905, issue of MACHINERY an abstract was given of a paper read by Mr. A. Mallock before the Institution of Naval Architects in which the author outlined his method of reducing or entirely eliminating vibrations in twin-screw steamers. Briefly it consists of means by which the engines are made to run at the same speed but in opposite phase. In other words they are made to run so that when, say, the port low-pressure piston is moving through the down-stroke, the low-pressure piston of the starboard engine is traveling in the up-stroke. Strangely enough the author did not dwell upon another and equally important result obtained by his invention, and that is, making the engines run at the same rate. To the uninitiated it may seem of little moment if one engine of a steamship does run slightly faster or slower than its mate, but such is not the case. If one engine is running faster than the other it means that the rudder must be deflected to counteract the greater effort of that screw, and this means lost effort. The maximum efficiency on a straight course, other things being equal, can only be gotten when both engines are running at exactly the same rate. Hence the Mallock device, while no doubt highly beneficial so far as reducing vibration is concerned, should be of still greater moment as regards efficiency, in that keeping the engines in step the waste effort is reduced to a minimum.

MELTING STEEL WITH CAST IRON.

At the New York meeting of the American Foundrymen's Association, June 6-8, Mr. R. P. Cunningham read a paper on "Melting Steel with Cast Iron," in which he describes his method of securing strong homogeneous semi-steel castings. In his preliminary remarks he refers to the great increase of the strength of castings now required as compared with that of a few years ago; it was unusual, years ago, to receive an order for a pump to stand a pressure of more than 1,000 pounds per square inch, but to-day it is nothing uncommon to get an order for a pump to work under a pressure of 5,000 pounds and even higher. Stationary engine builders are called upon to build engines to work under 200 pounds steam pressure, whereas a few years ago 100 pounds pressure was considered the limit. The same condition exists in machine tool building, the speed of modern tools being nearly double that of a few years ago. Car wheels are required to carry loads 100 per cent greater than was required of them twenty-five years ago. Hence the problem of making strong castings is a very important one and is one that must be met by the successful foundrymen.

Mr. Cunningham's method of charging a cupola is as follows: If a casting is wanted that requires 4,000 pounds of metal with 25 per cent of steel, a 48-inch cupola, say, is charged on the bed with 1,200 pounds of coke; on top of this coke is put 1,000 pounds of iron, then 500 pounds of soft steel scrap, then 500 pounds of iron, then 150 pounds of coke, 500 pounds of steel, 1,500 pounds of iron. With the last amount of steel $1\frac{1}{4}$ pounds of ferro-manganese should be added for every 100 pounds of steel used, and the same amount of ferro-silicon is put into the ladle. The results of 18 casts with different percentages of steel have apparently demonstrated that the highest amount of steel that can be used to advantage is 33 per cent. Higher percentages of steel than 33 per cent cause excessive shrinkage and only slight gain in strength. The highest tensile value reached with the test bars was 33,205 pounds and the lowest was 31,890 pounds for the perfect bars. The highest transverse strength was 3,335 pounds; the lowest for a perfect bar, 3,180 pounds. For ordinary work 25 per cent steel will give sufficient strength for all practical purposes and will make castings that machine easily and are close-grained.

BALANCING CENTRIFUGAL PUMPS.

A paper, "Some Types of Centrifugal Pumps," by Mr. Wm. O. Webber, read at the Scranton meeting of the A. S. M. E., gives something of the history of centrifugal pumps and reviews some of the improvements that have been made up to the present time.

The early centrifugal pumps had a single impeller, or runner; some of them had the suction on one side only and others had double suctions, or openings, on both sides. These early pumps had low efficiency. From 46 to 60 per cent seems to have been the best results obtainable under heads varying from $4\frac{1}{2}$ to 15 feet; 40 feet was formerly considered the maximum height at which centrifugal pumps could operate efficiently. Sulzer, of Winterthur, is credited with having been the first engineer to discover the value of compounding centrifugal pumps. Following him pretty closely are, A. C. E. Rateau, of Paris, France, and John Richards and Byron Jackson, of San Francisco, California. All the pumps designed by these men were constructed originally with the impellers facing in one direction; the consequent thrust on the impellers was partially taken up by balancing chambers upon the rear of each impeller. The residual thrust was further taken care of in Rateau's pump by a balancing cylinder, shown at the left of Fig. 1, into which water was admitted from the dis-

charge end of the pump. A similar arrangement was used in Richards' pump, shown at the right at *C* in Fig. 2.

Rateau further tried to improve the balancing of his pump by constructing enclosed impellers having one of the side plates of the impeller of smaller diameter than the other, so that the areas of the two impellers' side plates, subjected to the discharge pressure from the impeller, were equal. Sulzer then made a greater improvement in balancing by placing the impellers back to back in pairs, so that the thrust of one impeller was counterbalanced by that of the other. This method, however, required short tortuous distances between the pump chambers. Richards followed the same plan, but utilized it in a two-stage pump only.

Mr. Webber has designed a balanced compound centrifugal pump, in which the impellers are placed back to back, but not in pairs serially disposed, as will be noted in Fig. 3. In this design the sum and difference of the suctions of the discharge pressure of all the impellers balance each other. The Webber compound centrifugal pump has been built for heads of 1,200 feet, in which case two 4-stage pumps coupled in series are employed.

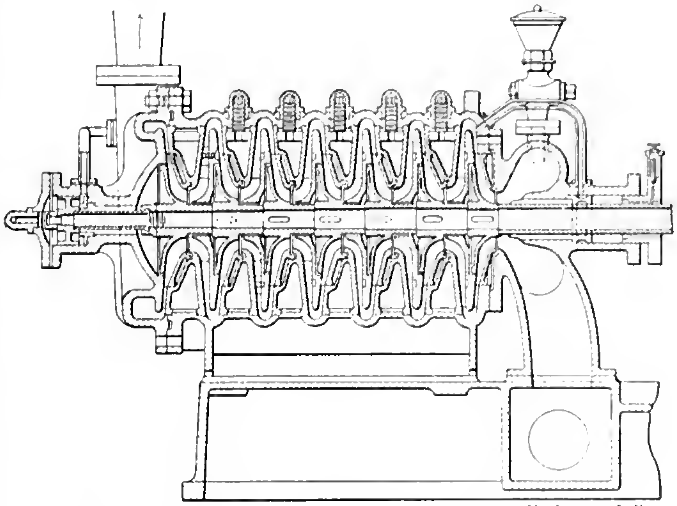


Fig. 1. Pump of Prof. A. C. E. Rateau, with Balancing Cylinder.

In connection with the foregoing mention may be made of a recent improvement in balancing centrifugal pumps patented by E. S. Lea and J. Degen, of Trenton, N. J., to which our attention has been called by Mr. Fred W. Barnaclo, of Francis H Richards' office, this city. This invention is shown in sectional view Fig. 4. The impellers in this pump are not placed back to back but follow the earlier forms of construction. The balancing feature is said to work automatically and to require no equalizing piston whatever. The action of the fluid flowing from the mouths of the impellers creates a partial vacuum

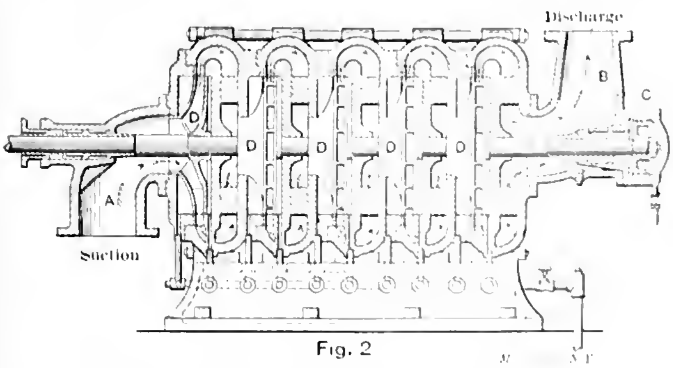


Fig. 2. Mr. John Richards' Balanced Centrifugal Pump

in the chambers *A* and *B* which, of course, reduces the pressure in these chambers. In order for the partial vacuum to be equal on both sides of the impellers, it is necessary for the distances between the rim of the impeller *D*, and the walls, *C* and *E*, to be equal. Should these distances on each side of the impellers be made unequal by shifting them axially, it will follow that the suction will also be unequal on each side of the impellers, and consequently the reduction of pressure would also be unequal. Hence the normal action of the impellers causes them to assume a central position.

THE REAL EFFICIENCY OF STEAM BOILERS

W. H. Booth, in Electrical Review (London), May 26, 1905

In calculating the efficiency of a steam boiler the customary method is to find the ratio between the number of thermal units contained in the steam produced by the boiler and the calorific capacity of the fuel burned to produce that result.

The calorific capacity of a fuel is usually stated as the number of thermal units that it will produce when burned, and it is assumed that if there is hydrogen in the fuel the water

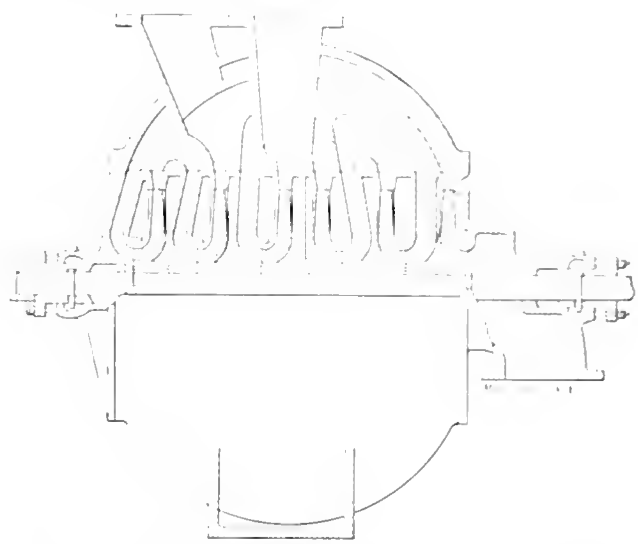


Fig 3 Balanced Compound Centrifugal Pump of Wm O Webber

produced by this hydrogen shall be assumed to be finally measured as water, and not as steam, at the initial temperature of the atmosphere to which the products of combustion are supposedly returned. Theoretically this is correct enough indeed, considering that the hydrogen in the coal is in solid form, whatever the chemical composition of such solid may be, it would appear to be fully as correct to base the calculation on the supposed return of the products of combustion to the

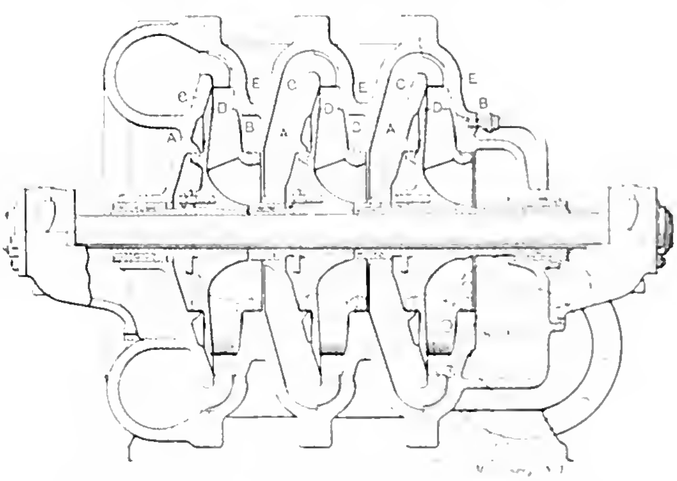


Fig 4 Improvement in Balancing Centrifugal Pumps of E S Lea and J Degan

state of a solid. However, assuming the ordinary practice, it seems scarcely correct that a boiler should be debited with all the thermal units produced by the hydrogen when it is impossible that the water produced shall be reduced to liquid form. Occasionally in flue feed heaters or economizers, the water, or some of it, is condensed on the colder lower ends of the water pipes, and combining with the products of the combustion of the sulphurous parts of the fuel, produces very rapid and serious destructive corrosion of the external parts of these pipes, so that in practice good maintenance involves as a *sine qua non* that the water shall not be asked to give up its latent heat, and it is found not to do so unless the surfaces with which it comes in contact, fall below about 100 degrees F. The true calorific capacity of a bituminous or hydrogenous fuel ought therefore to be calculated on the basis of 52,290 B. T. U. per pound of hydrogen, in place of the customary 62,100 B. T. U.

Since no boiler works below 100 degrees F., this correction

from customary methods ought properly to be made in the calorific value of a fuel, but it should be stated, of course, in any test figures, since the use of the incorrect figure is so firmly established, and the newer figure is just the sort of thing that the company promoter's expert would be likely to fasten upon to embellish his results, much as he now will sometimes innocently state the calorific capacity of fuel in B. T. U. without troubling to mention that he means per kilogram, or *vice versa*, if the other way around better suits the desired end.

But even the above method of stating fuel capacity is not right, and it tells against the high-pressure as compared with the low-pressure boiler, which is so much cooler, and is therefore better able to absorb lower temperature heat.

It is an obvious impossibility for a steam boiler producing steam at a temperature of 290 degrees F. to reduce the temperature of the waste gases below 290 degrees F. It would require an infinite area of heat-absorbing surface to effect even this result, but it can at least be stated that the temperature of the boiler itself is the minimum to which furnace gases can be reduced by the boiler unaided by a lower stage of feed heating in a separate vessel. Seeing, then, that a boiler cannot absorb the heat below 290 degrees F. in the suppositious case, is it reasonable to base the efficiency coefficient of a boiler upon the amount of heat supplied to it at any temperature? It would appear to be more correct in every way to debit the boiler with all the heat supplied to it above its own temperature, which is, of course, that of the saturated steam within it.

Thus, let it be assumed that a fuel consists of pure carbon giving 14,647 B. T. U. per pound, what is the efficiency of a steam boiler which produces per pound of fuel, only 10 pounds of steam at 174 pounds absolute pressure from feed water fully heated to 370 degrees F., which is the boiler temperature? The steam contains 8,521 B. T. U. of latent heat, and the customary efficiency of the boiler would be $\frac{8521}{14647} = 58.1$ per cent.

The furnace products weigh, we will say, 22 pounds per pound of fuel, and the boiler temperature is 370 degrees, while the external atmospheric temperature is 40 degrees F. Then the furnace gas is carrying away, or, rather, must carry away not less than 330 degrees of temperature, and its specific heat is 0.24. Then $22 \times 0.24 = 330 = 1,722$ B. T. U. The maximum available calorific capacity of the fuel is therefore only $14,647 - 1,722 = 12,925$ units, and the actual efficiency of the boiler is $\frac{8521}{12925} = 66$ per cent nearly, or 8 per cent more than shown by ordinary methods. However large the boiler, it could not possibly have absorbed more than 12,925 units. The possible performance is, in fact, only a full 88 per cent of the fuel capacity, and as no boiler is likely to reject gases at less than 100 degrees above its own temperature, the practical efficiencies are much less than present crude methods would indicate.

As an example, let the above number of units, 1,722, be subtracted from Shireoaks coal which has recently been stated to possess 11,886.7 B. T. U., and to be associated with an efficiency of over 84 per cent. We have $11,886.7 - 1,722 = 10,164$ as the maximum heat available. Now if 11,886.7 units show 84 per cent efficiency, the boiler must have absorbed 9,985 B. T. U. But $9,985 \div 10,164 =$ true efficiency of boiler $= 98.2$ per cent. This figure shows how very easy it would be to obtain a real efficiency of heat absorption of over 100 per cent by making an error in the value of the fuel. It also shows how very serious may be the effect of excess of air in high-pressure boilers, for an excess of air raises the number of heat units which lie below the datum line of possible heat absorption, not to name that of practicable heat absorption. It is much to be desired that boiler efficiencies should be based on the correct available heat value of the fuel, that is, on the heat supplied above boiler temperature. It may be argued that this brings the furnace into the account. So it does, but it also serves to draw attention to the harm done by inefficient combustion and excess of air, and if furnaces and boilers are to be rated as one, it would tend to better furnace practice. Boiler efficiencies would all appear higher than they do now, but some of the present high efficiencies claimed would not bear investigation.

REINFORCED CONCRETE.

Engineering, London, April 28, 1905.

Up to the last few years the use of concrete as a building material was chiefly confined to the construction of foundations, piers, reservoir dams, and similar purposes, in which the stresses to be met were almost entirely simple pressures. Indeed, even fifteen years ago many engineers looked askance on the use of concrete for arches, considering it for this purpose much inferior to brick. Much of the caution shown in extending the uses of this valuable material doubtless arose from the frequency with which concrete masonry exhibited unsightly cracks, due largely to the material being allowed to get dry while hardening. At the same time, careful examination has shown that cracks of the same character are common in masonry of all kinds, but are unnoticed, because they follow the regular joints of the structure; whereas on the smooth uniform surface of concrete, cracks of much less significance are immediately visible.

The plan of reinforcing the material with metal, of which several systems have been introduced during the last four years, has greatly extended the possible use of concrete; and it appears that in many cases a reinforced concrete bridge may compete, even in first cost, with a steel girder; while as regards upkeep, it has, of course, many advantages. Small bridge culverts of this material were extensively used by Russian engineers in building the Manchurian Railway. For openings of some 7 feet span, flat slabs of concrete reinforced with rails were used, the thickness being 8¼ inches. A similar system was used for spans up to 21 feet, the concrete, however, being thickened at the center as the span increased, the depth at this point being 2 feet 6¼ inches for the 21-foot span, and proportionately less for smaller openings. The thickness at the bearings was, however, the same in all cases, viz., 8¼ inches. The line was thrown over the spans as little as seven days after completion. The concrete consisted of one part cement, two sand, and five broken stone. The system in this case had great advantages, as stone for masonry was unobtainable, and could, moreover, only be used for arches, which would have necessitated the use of higher embankments than were required with the ferro-concrete used as described. Much larger spans have, of course, been built than those mentioned. One of 153 feet span, carrying four main-line tracks, has recently been built for the Lake Shore and Michigan Southern Railroad, while Mr. Edwin Thacker, M. Am. Soc. C. E., states he considers the system feasible for spans up to 500 feet, and has actually got out designs for a span of 300 feet, the cost comprising favorably with that of a steel bridge.

One great drawback to the extension of the system lies in the difficulty of proportioning structures thus built in a thoroughly rational manner. In the case of steel bridges, certain simple assumptions as to the elasticity and strength of the material suffice. These assumptions are doubtless not absolutely exact, but are sufficiently near the truth for practical purposes. The elastic properties of concrete are, however, very different from those of steel; Hooke's law is not even approximately correct, and, moreover, the material always takes a permanent set when first loaded. The true distribution of the stress and strain on a concrete beam is thus a much more complicated matter than it is in the case of a steel joist, in which it is permissible, within working limits of stress, to assume the accuracy of Hooke's law. The assumption generally made in the case of ferro-concrete is that plane sections of a concrete beam remain plane after bending. This postulate is, of course, that commonly made in proportioning steel work; and in the latter case, stress being proportional to strain, the usual formula for the working strength of beams is readily deduced. In the case of concrete, however, the stress-strain curve is much more complex.

In view of the uncertainties introduced by the different factors above mentioned, it is really questionable whether, after all, the theoretically objectionable formula of M. Henne-

bique is not as good as any other. The latter all involve a preliminary calculation of the position of the neutral axis, which varies with the percentage of metal used, and with the type of stress-strain curve assumed for the concrete; and also with the maximum stress at any particular section. Thus, in a centrally loaded beam its position at the ends is entirely different from what it is at the center. M. Hennebique, on the other hand, makes no attempt to locate this neutral axis, and simply assumes that one-half of his beam resists compression, and that the stress is uniformly distributed over this half. The moment of this compression about the center of the section he equates to half the moment due to the load, and the other half of the moment due to the load he equates to the moment about the center of the section of the tensile stress on the metal reinforcement. The working strength of concrete in compression he takes as 350 pounds per square inch, and neglects entirely its strength in tension. The working tensile stress on the steel reinforcement he takes as 14,000 pounds per square inch. The method is, of course, totally illogical, yet many thousand cubic yards of ferro-concrete have been successfully designed on these lines; and a comparison of the strength of the ferro-concrete beams as calculated by this formula, and by those of a more rational type, shows very little difference between the two for a considerable range in the ratio of metal to concrete. On the other hand, it must not be forgotten that formulæ, which are non-rational in form, are always risky when applied to extreme conditions.

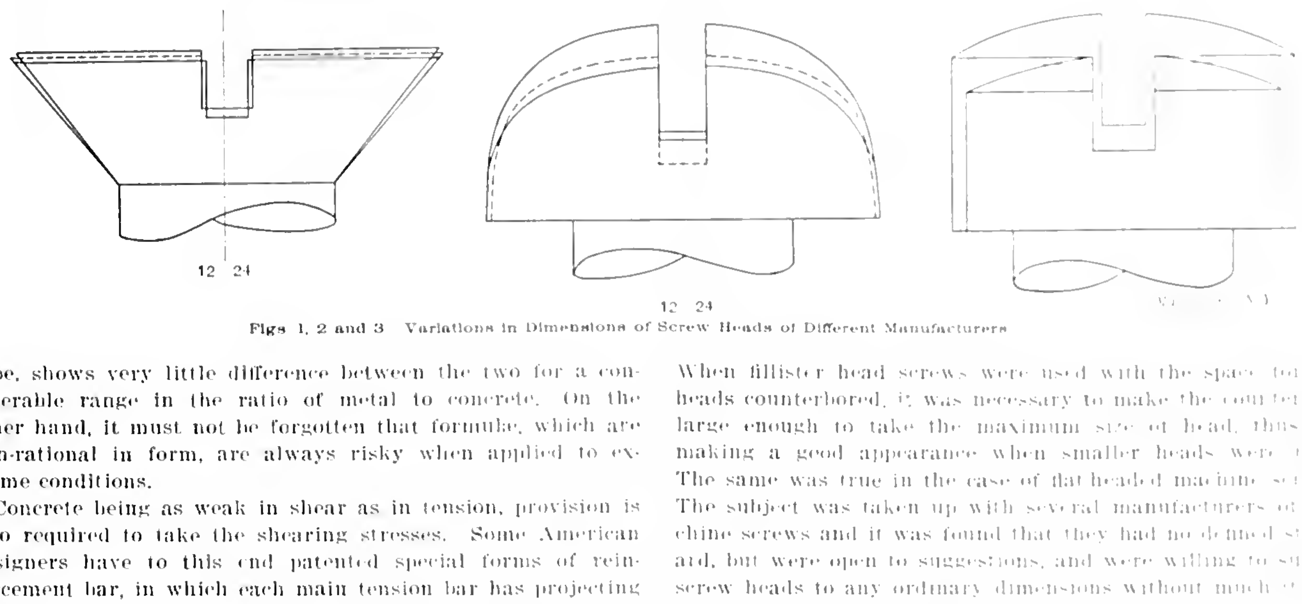
Concrete being as weak in shear as in tension, provision is also required to take the shearing stresses. Some American designers have to this end patented special forms of reinforcement bar, in which each main tension bar has projecting upward from it ties inclined at an angle of 45 degrees. These extend to the top of the bar and take the tensile stresses arising from the shear. The corresponding compressive stress at right angles to this is carried by the concrete. The system is doubtless efficient, and on large spans, where weight must be reduced to a minimum, it may have some advantage; but in work of ordinary proportions it seems to be little superior to the Hennebique system, in which the necessary strengthening is provided by stirrups of flat iron bent into a U shape. The main reinforcing bars rest in these stirrups at the lower ends. The spacing of the stirrups depends upon the "web stresses" to be taken, which can easily be calculated by assuming the reinforced beam to be a latticed girder, the lower chord of which is represented by the metal reinforcement, the upper one by the center of the compression half of the beam, while the stirrups represent vertical ties, which may be taken as connected together at top and bottom by inclined imaginary struts. The advantage of this simple method of reinforcing for shear lies in the possibility of using common rolled sections for the whole of the reinforcement.

Occasionally doubts have been expressed as to whether the metallic reinforcement may not suffer from corrosion as time goes on. This would be extremely dangerous if it occurred, since the metal being out of sight, its loss of strength might remain undetected until, some day, the structure might fail under its ordinary working load. Fortunately, much evidence is available to the effect that steel or iron thoroughly embedded in concrete are permanntly protected from rust. Our American friends, indeed, are so positive on this point that they have recently constructed a number of reservoir dams in ferro-concrete. In some cases these have been a[illegible], but in others they have been straight. The cross-section in the latter case is generally a hollow triangle, the sides of which are connected together by diaphragm walls from point to point. The dam is also anchored to its site, though generally the weight provided is sufficient to make the structure safe against overturning, quite apart from the help received from the anchor-bars.

NOTE ON HEADS OF MACHINE SCREWS

Paper by H. G. Reist, read before the Scranton Meeting of the A. S. M. E.

The size and shape of machine screw heads as made by different manufacturers vary greatly. In the case of screws made by some manufacturers the heads used on different sizes have different proportions, thus presenting a different appearance. The company with which I am connected is a large consumer of machine screws, and this variation has from time to time caused great inconvenience. Frequently designs are made to suit the screw heads of one manufacturer, and if afterward it becomes desirable to purchase screws manufactured elsewhere, there may be an interference with other parts of the machine, due to the variation in size of heads.



Figs. 1, 2 and 3. Variations in Dimensions of Screw Heads of Different Manufacturers

When fillister head screws were used with the space for the heads counterbored, it was necessary to make the counterbore large enough to take the maximum size of head, thus not making a good appearance when smaller heads were used. The same was true in the case of flat headed machine screws. The subject was taken up with several manufacturers of machine screws and it was found that they had no defined standard, but were open to suggestions, and were willing to supply screw heads to any ordinary dimensions without much if any extra cost. The extreme variation in dimensions found is

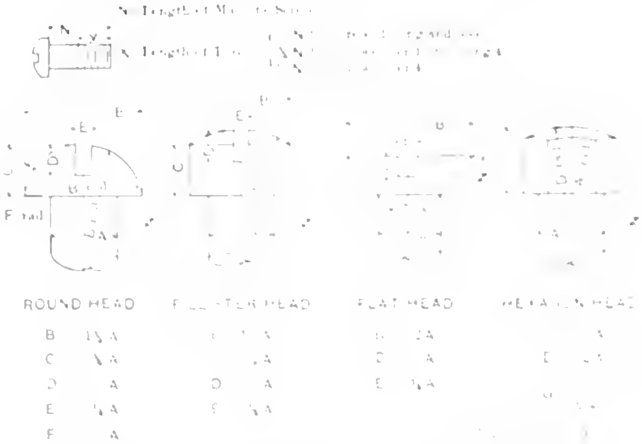


Fig. 4. Standard Proportions Adopted for Screws by G. E. Co.

shown graphically in the accompanying drawings (Figs. 1, 2 and 3), from which it will be seen that there is great diversity, and, as stated above, the same manufacturers will in some cases supply larger heads proportionally than others. (See Figs. 1, 2 and 3.)

In order to establish uniformity in our own works, we prepared the accompanying formula and table giving the shapes and dimensions of the heads of the sizes of screws ordinarily used. The shape and proportional dimensions of these heads are shown by the broken lines in the drawings of the several forms of screw heads. It will be seen that these heads pre-

sent a uniform appearance, and by submitting the table of dimensions we have had no difficulty in obtaining screws to the dimensions shown—in fact, the manufacturers have expressed themselves as pleased to have a standard to work to.

The author understands that there is a committee (appointed by the society) at work on the standardization of machine screw threads, and it would seem to him that a report from them along these lines might make a valuable appendix to their work.

SMOKE AND ITS ABATEMENT.

Abstract of Paper by Prof. Chas. H. Benjamin, read before the Scranton Meeting of the A. S. M. E.

Objectionable black smoke is due to the presence of hydrocarbons in the fuel and is produced as follows: The hydrogen and carbon compounds in the coal are driven off as gas by the heat at a comparatively low temperature, and may escape unburned. In this condition they would not constitute smoke in the common sense of the term. If heated to a sufficiently high temperature in the presence of air they burn with a yellow flame. If the air supply is insufficient, poorly mixed with gas, or if the temperature is lowered in any way, combustion is checked and carbon is deposited in the form of soot, or carried off with the gas as smoke.

Only three conditions are necessary for complete combustion, the proper temperature, the proper air supply, a thorough mixing of the air and the hydrocarbons.

The last condition is as important as any and is one too often neglected.

It is this condition which gives the gas or liquid hydrocarbon an advantage over the solid, since the atomizing of the former by the steam or air jet insures the most intimate contact between the air and the fuel.

The use of pulverized coal in combination with air or steam is a close approximation to the above, and, when properly managed, gives good combustion, no smoke and a high efficiency. The cost of pulverizing and the impracticability of storing pulverized fuel have, so far, hindered the more general adoption of this process, except for metallurgical work. When coal in the ordinary form is used as a fuel, smoke abatement involves some means of varying the coal supply and the air supply according to the demands made upon the boiler. When ordinary hand firing is resorted to, the great irregularity of the coal supply will cause poor combustion and smoke unless the air supply is varied to correspond. Steam jets are frequently employed under these circumstances, and, if properly put in, will improve the combustion by drawing in additional air over the grate and mixing it with the products of combustion in front of the bridge wall. The steam jet should be semi-automatic, the steam and air being turned on by the opening of the fire door and gradually closed off by a dash-pot attachment.

The best solution of the smoke problem, so far, has come from the introduction of mechanical means of handling the coal, which give a uniform feed to the fuel and a corresponding delivery of air for combustion.

The principle of the inclined grate stoker, as exemplified in the Wilkinson, Brightman and Roney stokers, involves the slow coking of the coal on a dead-plate, the pushing forward onto the top of the incline and the gradual descent, impelled by oscillation of the grate bars, until the combustion has left nothing but ash and clinker at the bottom.

When used with a fuel which does not cake or clinker too much and when not crowded too hard these stokers are economical and reduce the smoke considerably. If, however, it becomes necessary to slice and poke the fire on account of caking coal or overcrowded boilers, unburned masses of coal are rolled to the bottom and holes are made in the fire through which cold air rushes. Both of these circumstances make for poor combustion and a smoky fire. As a rule firemen poke the fire on stokers too much, doing more harm than good.

From observations covering a period of several years I have come to the conclusion that the traveling or chain grate is the best one yet devised for abating smoke. The grate used in the Babcock & Wilcox and Green stokers is of this type. To prevent waste through the grate the latter is usually quite close and it is necessary to use more draft than with an ordinary grate. A damper is used under the grate to prevent an excess of air passing up behind the grate or through the comparatively bare grate at the rear end.

Underfeed stokers operate on an entirely different principle, the coal being fed in underneath the grate and forced up through a rectangular opening in the center. A forced blast is used and the air for combustion is blown up through the coal, the tuyeres being on either side of the rectangular opening just mentioned. By this arrangement the fresh coal is always underneath and the distilled gases are obliged to pass through an incandescent mass of fuel in company with the air. With a proper pressure of blast perfect combustion is thus almost unavoidable. The ash and clinker are now at the top of the fuel, which forms a gradually rising mound in the center and pushes the clinker over to either side, whence it is removed by hooks through doors at the front. The heat generated is such that the ash generally melts and forms a sheet of clinker which can be easily removed without disturbing the fire.

I believe the automatic stoker is the most economical solution of the smoke problem. In forming this opinion I do not rely upon expert tests for efficiency; there are so many variables entering into the question that it is difficult to make accurate comparisons in this way. As it is entirely possible to improve the efficiency of a furnace ten or fifteen per cent by intelligent hand firing, there is much difficulty in determining the actual saving effected by a stoker. During a competitive test between the hand-fired furnace and the stoker the conditions are often entirely different from those obtaining in every-day use, and these changed conditions are usually more to the advantage of the hand firing.

By this I mean that good hand firing is the exception rather than the rule, on account of the dirty, disagreeable nature of the work and the low grade of help employed. With the introduction of mechanical handling there is a reduction in the quantity of manual labor and there should be an improvement in its quality. Manufacturers should understand that if they expect to get the benefit of improved machinery they must have men competent to run it to the best advantage.

The surest method of determining the relative economy of the two methods is by comparing the coal bills before and after the change, making due allowance for any variation in the work done. This has been done in a number of instances to my knowledge and the result has always been favorable to the stoker.

RECORDING ANGULAR VELOCITIES OF MARINE SHAFTING.

John H. Heck, Institution of Naval Architects, April, 1905.

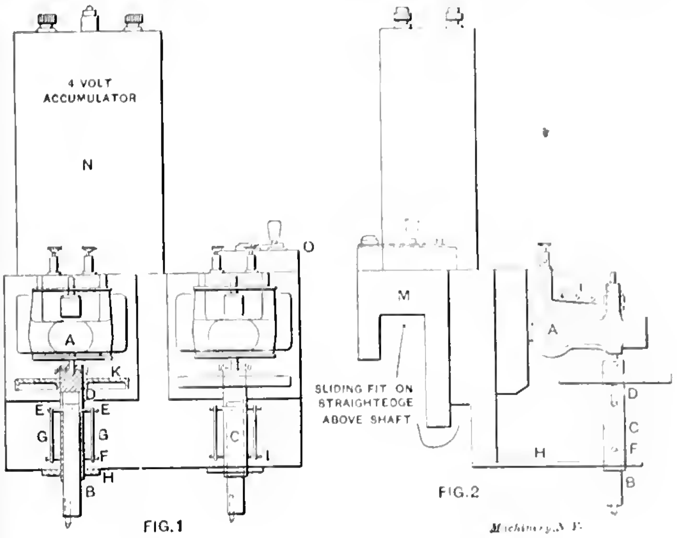
It has often been assumed in investigations on the balancing of engines which have appeared in papers read before technical societies, that the angular velocity of the shafting was uniform or nearly constant. Some tests carried out by the author of the paper here abstracted, show that such is often not the case.

The method successfully employed for the determination and recording of the variations of shaft velocity consisted of a small vertical electrical motor, which was kept constantly revolving at a high speed by means of a storage battery. At the lower end of the spindle of the motor, a brass sleeve containing a metal pencil-holder was fixed; this contained a lead pencil which was fitted eccentrically so that a circle about 5/16 inch in diameter was traced when the spindle revolved. The arrangement of this apparatus is shown in Figs. 1 and 2, in which two motors are shown to be used for checking purposes, although in a large part of the trials only one motor was used.

The motor was fixed to a small teak frame, which was so made that it could slide along a teak batten about six or seven feet long; this batten was fixed in the shafting tunnel in a fore and aft direction, by means of two special screw clamps clipping the angle-iron stiffeners on the tunnel sides in such a manner that the center of the spindle of the motor was directly over the longitudinal center line of the shafting, and the pencil point forced slightly upward, thereby extending a small spring by the tension of which the pencil-point was kept in contact with the paper on which the curves were

traced. This arrangement of the instrument in the shaft tunnel is shown in Fig. 3. For taking diagrams of velocity, a number of sheets of drawing paper were wrapped around the shaft and kept in position by elastic string.

The low-pressure crankpin was generally placed on the top center, the instrument started by switching on the current, and the motor frame pushed by hand slowly along the teak batten or straight edge, when the pencil traced a looped curve in the fore and aft direction; a line drawn through the center of the curve was taken as a datum line, and marked "L. P. crank on top"; the forward and after edges of the sheets



Figs. 1 and 2. Apparatus for Recording Velocities of Shafting

of paper were also respectively marked "forward" and "aft." The instrument was then either tilted or taken off, so that the lead pencil was clear of the paper.

When the engines were running at various speeds, the curves were obtained by bringing the pencil in contact with the paper, and starting the motor, which, when fully in motion, was pushed slowly along the batten by hand, the pencil thus describing a continuous screw thread of loop curves on the paper which enveloped the shaft. Fig. 4 shows some of the actual curves as they appeared when the paper bands were taken off the shafts. The distance between each small curve from crest to crest, represents the distance passed over by a point in the circumference of the shaft during practically a very small uniform interval of a second. By counting the number of loops in one series all the way around the shaft,

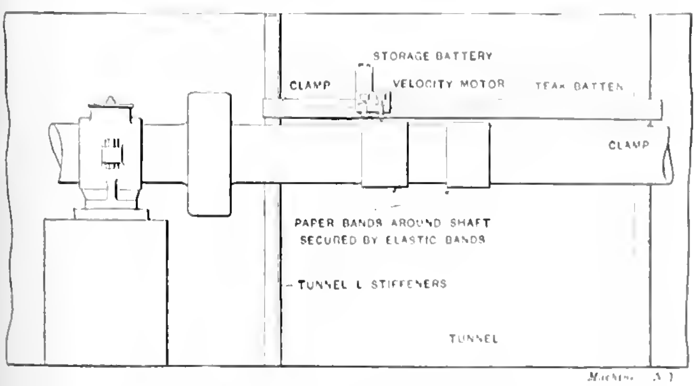


Fig. 3. Arrangement of Instrument in Shaft Tunnel

the number of revolutions of the motor for one revolution of the engine was determined, and by measuring the distance between the crests of the small curves and dividing this distance by the radius of the shaft, the angle in radians passed through by the crank could be determined.

Curves were taken in a number of vessels when the machinery was tested at sea, and also at the mooring trials. In a few cases where it was possible to test the engines under somewhat similar conditions, it was found that at certain revolutions the variation of angular velocity per revolution was less when the vessel was moored than when she was under way at sea.

Fig. 5 gives the recorded variation of angular velocity in one case, the points of the diagram being calculated from curves obtained as described, and connected by straight lines. The steamship on which this particular record was taken was a moderate size vessel fitted with two-crank compound engines working at eighty pounds pressure; weather fine; propeller well immersed. Comparing one 1/8 of a revolution with another 1/8 of the same revolution, the variation in the angular velocity of the shafting at 58 revolutions was 12 per cent, while making the same comparison with 1/4 of a revolution the variation was 8.6 per cent. In this connection it may be said that the tests seemed to show that two-crank engines, even though well arranged and designed, are not so efficient for marine service as engines with a greater number of cranks. A large steamer fitted with three-crank triple expansion engines, working at 180 pounds pressure, for example, varied in the angular velocity of the shafting at 66 revolutions only 1.6 per cent, comparing one 1/8 of a revolution with another

Fig. 4. Set of Curves Taken. Vertical Line is the Datum Line or L. P. Crank on Top

1/8 of the same revolution; and at 51 revolutions 5.5 per cent. Making the same comparison with 1/4 of a revolution, the variation when running a mile at 66 revolutions, was 2.1 per cent.

As an illustration of the effect of slight racing on the variation of angular velocity of shafting, in the case of a large three-crank triple expansion engine steamship (table of tests not reproduced); when no racing was apparent, comparing one 1/8 of a revolution with another 1/8 of the same revolution, the average variation of the velocity in the shafting at 68 revolutions was 7 to 9 per cent, while, when racing was evident, the same comparison showed a variation in velocity of 21 per cent. In other words, while the average number of revolutions of the engine was 68 per minute, the engines actually, during a part of some of the revolutions, were going at the rate of 82 revolutions, while, during a part of other revolutions, they were going at the rate of 58 revolutions per minute. It therefore may be said that if similar tests were made at sea while the engines were racing heavily, the acceleration at intervals in the rate of revolutions per minute

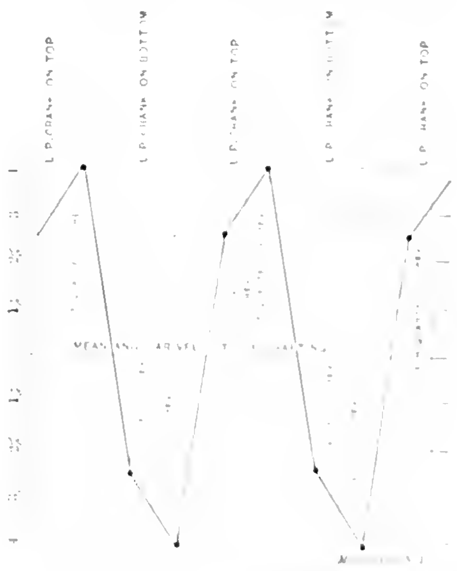


Fig. 5. Variation of Angular Velocity on Steamship having Two-crank Compound Engines

would be found to be quite sufficient to account for the signs of strain which have appeared in the machinery of vessels after encountering very bad weather.

The variation in the angular velocity per revolution was nearly always greatest at low speeds of revolution, and as the revolutions became greater the variation became less. When an exception to this rule took place vibration became apparent. The variation in angular velocity increased with the vibration increase. The ship when vibrating appeared to

act as a powerful brake on the engines, which was applied hard at some intervals of the revolutions and released at others. Up to a certain number of revolutions of a ship having triple expansion engines, tested, the variation of the velocity in the shafting was normal. At 82 revolutions, however, the vibration was considerable, and on comparing one 1/8 of a revolution with another 1/8 of the same revolution, the velocity was found to vary from about 12.5 per cent above to 12.5 per cent below the mean angular velocity of the shafting.

CAN A STEAM TURBINE BE STARTED IN AN EMERGENCY QUICKER THAN A RECIPROCATING ENGINE OF THE SAME POWER.

Paper by A. S. Mann, Read before the Scranton Meeting of the A. S. M. E.

If a large steam turbine is cold and at rest how quickly can it be started? Can it be brought up to speed as readily as can a good cross compound engine that is cold all over?

Most station men would have doubts as to the adaptability of the large turbine, say 1,500 kilowatts or 2,000 horse power, for emergency work. So much has been written about the sensitiveness of a rotating disk to the changes of temperature and the effects of unequal expansion that it is easy to imagine difficulties in the rapid start. The possibilities of an engine with a 62-inch low-pressure cylinder in starting practically cold and coming up to synchronous speed are well understood. A station manager would criticise an engineer who would open his throttle as fast as he dared without wrecking his piping system and let his machine jump into her work. One turn at a time on the throttle is about all that is considered safe, and even then a close watch is kept for groaning valves and cold back bonnets.

Every time the starting valve is moved to increase the steam flow the engine is allowed to take its full increment of speed, due to that particular throttle position before the supply valve is moved a second time. There are ten large oil cups, and frequently more, that must be opened and adjusted before the machine moves at all, beside whatever oiling is to be done about the air pumps and other auxiliary apparatus.

Most engineers would consider ten minutes as rather a fast start and fifteen minutes as a more usual starting period, including time taken for warming up; in fact, it may not be overstating the case to say that if it were known that an engine-driven plant were to be called upon in emergency for power and it were essential that the briefest possible time were to elapse between the call and the taking of the load, one or more engines would be kept in motion all the time, turning slowly and hot all over.

This question makes itself very prominent when the steam station is operated as an auxiliary to a large source of high tension power, which is itself in the construction stage and has a large overload capacity of its own to carry, supplying all sorts of apparatus that use electric power, railway, lighting and power circuits simultaneously. At such a time all sorts of accidents will happen to the high-tension water-driven plant, most of them due to the necessarily temporary character of many of the electrical connections. It takes months before an intricate system of wiring can be thoroughly relied upon, for it takes months before the temporary work of construction can be replaced.

The station at present under consideration is equipped with three Curtis turbine-driven alternators, 40 cycle, 10,000 volts, each of 1,500 kilowatts normal capacity. During the summer months the station is operated as an auxiliary to a water-power plant, taking all sudden overloads. A signal has been arranged, a 3/4-inch whistle, so that it can be blown instantly should the power fail. A blast of that whistle means—cut in two turbines and bring the third up to speed. The load will be heavy, and all auxiliary apparatus must be in regular operation. Each turbine has a surface condenser and there are three or four pumps to be started for each pair of turbines; one circulating pump, one combined hot-well and feed pump, one pressure pump for the step bearings and one dry air pump, all of which are motor driven. The exciter is driven by a steam engine and must be started also, for it supplies current to a portion of the auxiliary apparatus.

The boiler room has steam up at all times, supplying a system for manufacturing purposes other than power, and slow fires are kept in enough boilers to make steam needed for the normal load. Forced load means forced fires. The boilers have underfeed stokers, equipped with pressure blast, and will respond quickly to a 50 per cent excess call for steam. The operating force for this is about equivalent to a force for an engine-driven plant. Engineers and oilers, however, are busy about the building on construction work, installing new apparatus and taking such work as their regular occupation when the turbines are not running.

At the sound of the whistle the water-tender starts a blower on the extra row of boilers; all blast dampers are opened up and all stokers are allowed to feed at the maximum rate. Each fireman dumps his free ash and bars over his red fire. The man in charge of the coal and ash conveyor starts the pressure pump for step bearings. One of the turbine men starts the exciter which supplies current to the auxiliaries beside its field current; a second turbine man starts the circulating pump and then his turbine. The hot-well pump and the air pump are started by the oiler. These movements take place simultaneously. The force is organized upon the lines that obtain in a fire station; each man has his specific duty, and after performing it looks to see that there is nothing more for him to do. Only a few seconds elapse between starting the first pump and starting the first turbine.

The turbine throttle is opened as fast as an 8-inch steam valve can be opened without endangering the steam piping system. It is not considered advisable to open the throttle valve as fast as a man's strength will permit; but if nothing unusual occurs in the pipe line, sentiment does not spare the turbine. One electrician attends to the switchboard and telephone. As soon as the machine approaches speed, the synchronizing system is cut in and the main switches are got ready. One and one-half minutes will do all the work here outlined, including the time taken in mustering the crew from various parts of the building, itself not a trivial matter.

Manipulating an engine regulator so that it shall be at a precise speed and at an exact phase relationship from some other machine, not more than 1-1500 part of a second removed from it, is no matter that can be hurried, and one minute is fast time on such work. But the whole thing, phasing-in and all, has been done in 2½ minutes, including full load on the turbine, which started from a standstill. This performance has been gone through a great many times, and our record book shows that out of 43 such calls, 10 starts were made in 2½ minutes, 18 in 3 minutes and 15 in 3½ minutes.

We have taken the time in a number of instances when all the auxiliaries have been in motion and it only remained to start the turbine and phase it in on the line; the only valves to open in such cases are the throttle and one small oil valve. The two quickest starts have been made in forty-five seconds and seventy seconds, respectively, including phasing in. Others range between one minute ten seconds and one and one-half minutes. These two quickest starts were made on a turbine which had stood for twenty-four hours with the throttle valve shut tight though there was a slight leakage past the seat. After the throttle valve is off its seat it is not more than thirty seconds before the turbine is up to speed. A cross compound reciprocating engine of the four-valve type, 2,000 horse-power capacity, can be brought up to speed from a standstill in five minutes if it is hot all over. This five minutes is to be compared with the seventy seconds required for the similar turbine operation.

A reciprocating engine, which is turning over slowly with the throttle valve just off its seat or with by-pass open and having all its oil cups open and regulated, can be brought up to speed, say seventy-five turns, in two and one-half minutes. This can be compared with the thirty seconds necessary for bringing the turbine up under the same conditions; that is, about one-fifth the time necessary for bringing up the engine. If the engine is cold all over and has all its oil cups shut tight, all its auxiliaries quiet, fifteen minutes is called a rapid start. Starts have been made under such conditions in twelve minutes. When we start a cold turbine, we open up the valve and let her turn, and in two minutes we are ready to bring her up to speed and she will be at speed in two and one-half minutes, dividing the engine's time by more than four.

SCRANTON MEETING OF THE A. S. M. E.

The annual meeting of the American Society of Mechanical Engineers was held at Scranton, Pa., on June 6 to 9 inclusive. The opening session was in the evening at the Y. M. C. A. hall, where usual courtesies were extended in the way of an address by a representative of the city and a reply by the president of the society. Following these preliminaries was the presentation of the papers assigned to the first meeting.

"The Transfer of Heat at High Temperature" by Prof. Frank C. Wagner, of the Rose Polytechnic Institute, summarized experiments to determine the time required to raise plates of iron and steel to a welding temperature in an open hearth regenerative furnace. This paper was of more interest to metallurgists and physicists than to mechanical engineers and is not suitable for abstracting here. A similar remark can be made in regard to several of the other papers presented at the several meetings, and in this report only those papers will be mentioned hereafter that are likely to interest MACHINERY readers, since a complete list of the papers was given in the last number.

"The Standard Unit of Refrigeration" by F. E. Matthews, of the De La Vergne Refrigerating Machine Co., New York, was a paper in which the author attempts to crystallize ideas on this subject, with the hope that it may lead to the final adoption of some standard unit of refrigeration.

The final paper of this session was upon "Some Types of Centrifugal Pumps," by William O. Webber, consulting engineer of Boston, Mass. This paper called out the most discussion of any, and is abstracted in the Engineering Review. It was pointed out in the discussion that centrifugal pumps might be used to advantage in oil pipe lines, and for many other purposes where plunger pumps are now used, although doubt was expressed as to its adaptability to water works duty unless the steam turbine should be so far developed that the two types of rotary machines, the turbine and rotary pump, when connected should be found suitable for this class of work.

Wednesday Morning Session.

This session was opened by a short business meeting, during which Mr. C. W. Hunt reported the progress of the plans for the new Carnegie engineering building. It was said that the architects and the plans had been selected with the greatest care, and it was believed that the plans would meet every requirement. They not only provide a building sufficient to house the three great engineering societies, but also provide sufficient accommodations to enable the building to serve as headquarters for other engineering societies, thus making it the great center of the country for men engaged in different branches of engineering work.

The question of the place for the next spring meeting came up and it was decided to accept an invitation from the engineers of Chattanooga, Tenn. It was represented that the city has many attractions for visitors and that its diversified industries are of unusual interest to those mechanically inclined.

Following the business meeting was a paper upon "The Microstructure and Frictional Characteristics in Bearing Metals," by Melvin Price. The investigation recorded in this paper was conducted at Columbia University, and was an attempt to trace the relation between friction and the composition and structure of bearing metals, although unfortunately the results obtained did not seem to have repaid the immense amount of labor required for the experiments.

Mr. W. J. Keep, Detroit, Mich., added to the large fund of information that he has contributed at various times upon cast iron and its properties, by a paper upon "The Crushing Loads and Microstructure of Cast Iron." This series of tests is valuable on account of its completeness and because a chemical analysis was made of each size of test bar used.

The most interesting paper of the meeting was by Professor Charles H. Benjamin, of the Case School of Applied Science, of Cleveland, O., upon "Smoke and Its Abatement." This paper is reviewed in the engineering edition of this month.

Wednesday Evening Session.

An interesting and practical paper upon "Steam Turbine Operation" was given by A. S. Mann, Schenectady, N. Y. He outlined provision made in a station containing Curtis steam turbines for placing the turbines in operation in an exceedingly short space of time when required by an emergency. The turbines serve as auxiliary power in a plant normally provided by water power and in case of the latter failing, turbines could be started in from two to three minutes, carrying full load. This paper appears in the engineering edition.

Mr. A. Bement, the specialist in combustion and boiler practice, of Chicago, presented two papers, one upon "The Efficiency of Steam Generating Apparatus," of which he had made special study, and the other upon "The Performance of a Superheater."

A new type of valve gear actuated by steam was described by W. A. Collier, Jackson, Tenn. The valves are of the Corliss type, operated by small steam cylinders to which steam is admitted and released by small valves controlled by a valve gear receiving motion from the engine shaft. This gear is said to give an unusually good steam distribution, to be cheap to construct, and after six months' use at a speed of 100 revolutions per minute, has shown no appreciable wear.

Thursday Morning Session

This was the concluding professional meeting and was opened by a brief paper, given in our engineering edition, upon "Proportions and Heads of Machine Screws." It was shown that dimensions vary greatly among different manufacturers and a table of dimensions that was believed to be well adapted for general use was given.

Professor W. W. Bird, of the Worcester Polytechnic Institute, presented a new treatment of the already rather worn-out subject of "Belt Creep." The paper described the 4-inch and 6-inch single and double endless belts, and it was concluded that the belt creep should not exceed 1 per cent.

Another well-worn subject was introduced by Professor Chas. E. Lucke, upon "Laboratory Courses in Engineering Schools." He gave to the subject, however, a freshness of interpretation and treated it in a common-sense way which made it of unusual interest and won the approval of several educators who commented upon it. He criticised the usual method of instruction and held that the chief functions of laboratory work are first to teach the student how to make the standard commercial tests; second, to judge and criticise data and records in books and professional papers; third, to judge the limits of practical performance for machinery of all classes; fourth, to learn how to approach a new problem and to outline a method of attack preparatory to its solution.

The concluding paper was by Rear-Admiral Melville, upon "Epochs in Marine Engineering." This paper is the same that was presented at one of the local winter meetings of the society in New York, and has already been abstracted in MACHINERY.

As usual at the June meetings of the Society, the excursions were perhaps the most appreciated as well as the most useful part of the proceedings. At Scranton, the most prominent point of interest is the International Correspondent Schools, whose business has reached a magnitude that is probably not appreciated even by many technical men. This institution sends out as much mail as is dispatched by the whole of the city of Scranton, numbering 110,000 inhabitants. Demonstrations of the phonographic system of instruction in language were given. Inspection was made of the text books and other material published for the various departments, and the printing department elicited much favorable comment. This is a model plant, said to be one of the largest in the country. Visits were also made to the Allis-Chalmers Works, formerly the Dickson Machine Co., to the Lackawanna car shops recently completed, the Hampton Power Plant, equipped with Curtis turbines, and the Hampton water hoist, in which two buckets, each with a capacity of 17 tons of water, are operated electrically by a 800 H. P. motor, raising water from a depth of 500 feet. The complete cycle of one bucket is made in about one minute at 1.55 seconds.

On Friday, the last day of the meeting, a trip was made over the new third rail road running between Scranton and Wilkesbarre. This line is familiarly known as the Laurel Hill line, is double-tracked, and is about twenty miles long. It owns its right of way and has a heavy traffic. The road is of unusual interest and is one of the best examples of electric rail-

way equipment in the country. The power plant is at Scranton, equipped with Westinghouse vertical engines operating generators in multiple, and supplying both direct and alternating current. There is a sub-station at a mid-way point on the line which converts the alternating to the direct current and reduces its voltage. A number of points of interest were visited at Wilkesbarre.

* * *

NEW LIFTING MAGNET.

A new lifting magnet has been brought out by the Electric Controller and Supply Co., Cleveland, O., of much larger capacity than the magnet illustrated in our May number. This magnet is shown in three views herewith and is of a type designed for handling stock such as pig iron, light or melting stock, small castings, bolts, rivets, iron turnings, etc. This magnet has a lifting capacity of 1,200 pounds of pig iron, small castings, or of bolts, nuts, etc. It will lift 1,100 pounds of medium-weight castings, and a "skull-cracker ball," used for breaking up scrap in the foundry yard, of 11,000 pounds

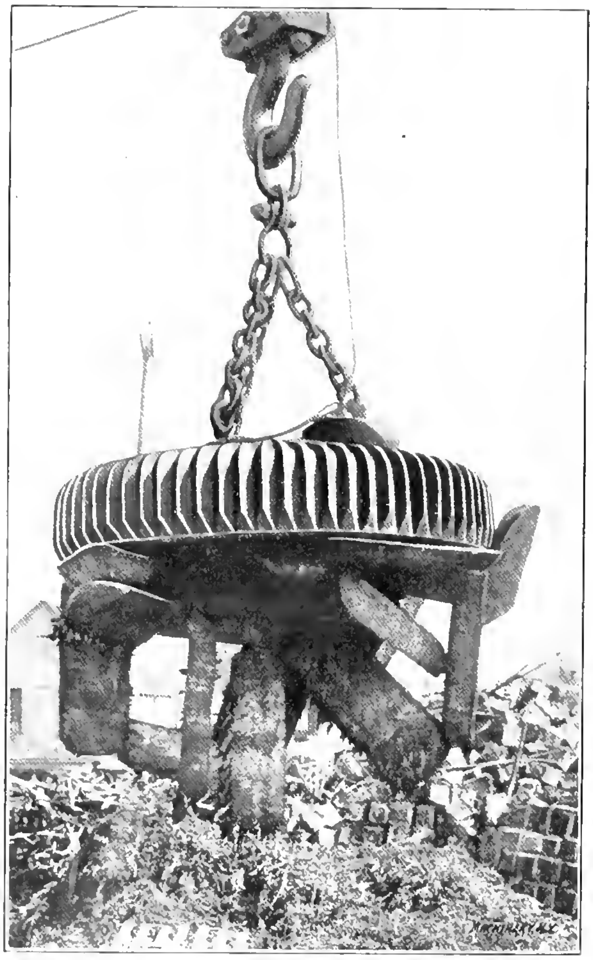


Fig. 1. Electro-magnet Lifting Machine-cast Pig Iron.

weight. It will be seen from this that a lifting magnet will raise a much greater weight when the latter is one piece than when there are a number of small pieces which not only cling to the magnet, but to each other.

A magnet of the type shown is adapted for loading or unloading cars, piling stock, and for general carrying purposes. Assuming its average lift to be 1,000 pounds, and the work to consist of loading from cars into furnace-charging boxes for the foundry cupola: if the crane man can make a transfer in 45 seconds, or at the rate of 90 per hour, and the crane works eleven hours in each twelve-hour turn, a crane using this magnet will have a loading capacity of 1,000 × 90 × 11, divided by 2,000, or 494 tons per turn. With this magnet, therefore, a 5-ton crane could serve four such furnaces with ample safety, thus increasing the capacity of the crane besides saving the labor ordinarily used for filling the boxes. For breaking scrap, the magnet takes the place of the ordinary latch hook used for raising the skull-cracker and will lift the bolt in any position, making it unnecessary to waste time in getting the bolt so located that it can be attached to the hook of the hoisting rope. There is no necessity for any yard men to be near when the ball is dropped, as the magnet is controlled by a hoist operator at a safe distance and there is therefore no danger from flying scrap. Another advantage of the magnet for this work is that there is no jerking of the supporting rope as is the case when the latch is released, with the ordinary apparatus, so that the aim is sure and every blow effective.

Fig. 2. Mass of Iron Turnings Lifted, showing extent of Magnetic Field.

In the accompanying illustrations, Fig. 1 shows one of these magnets lifting machine-cast pigs from a deep pile and gives an idea of the rapidity with which this class of material can be moved either in the yard or in loading or unloading cars without having to handle it by means of manual labor. To raise his load the crane operator has simply to turn on the current and set the crane in motion; while to deposit the load he lowers the magnet and turns off the current. Fig. 2 shows one of these magnets that has picked up a load of iron turn-

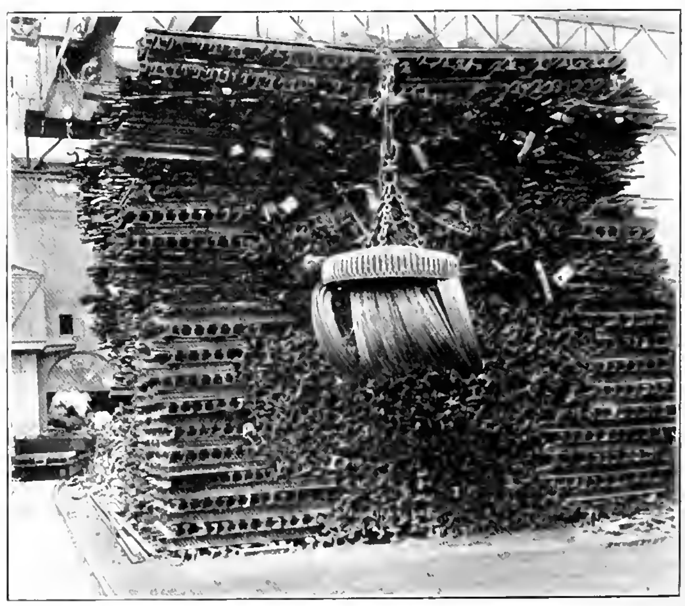


Fig. 3. Magnet Carrying Wire Coils.

ings from a pile, and the shape of the mass of turnings that has been raised indicates the extent of the magnetic field of the magnet.

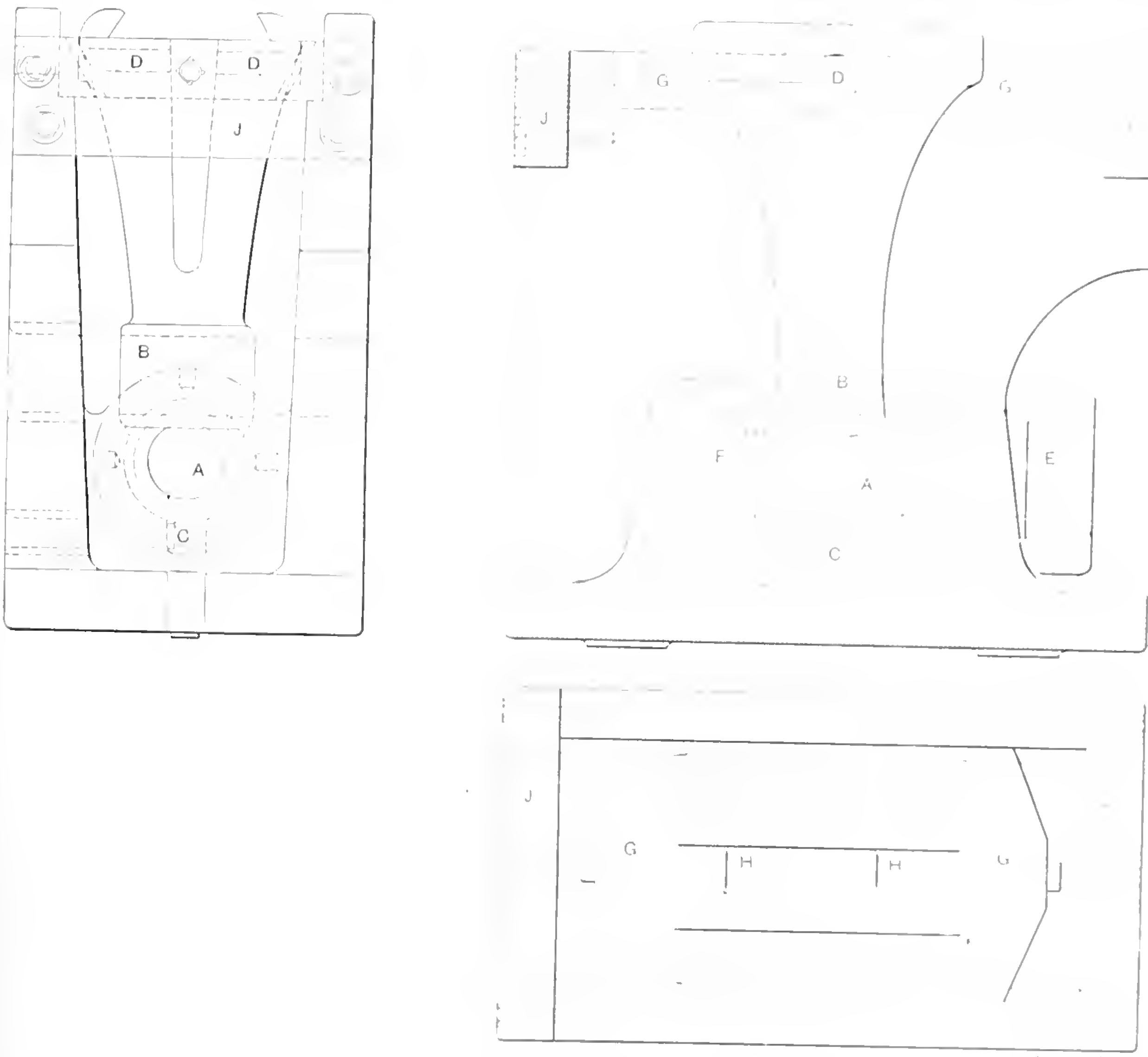
Fig. 3 shows a magnet carrying several coils of wire, the magnet being suspended from the crane, one end of which appears in the upper left-hand corner of the engraving. The pile of scrap at the rear was piled by the magnet, and it will be noted that it extends up almost to the level of the crane girders. By the use of magnets it is possible to handle stock to a greater height than in any other way, because less head room is required for attaching to the crane hook.

LETTERS UPON PRACTICAL SUBJECTS.

MILLING AND DRILLING JIG.

Editor MACHINERY:

I send you three views of a jig for milling and drilling the sliding heads of small sensitive drill presses. It is another example of the type of screw bushing jigs described in the December, 1904, issue, but with some slight modifications. One of the essential requirements of the jig was that the hole, *A*, which receives the spindle, should be accurately bored in the center of the boss so that the machine when finished should present a pleasing appearance to the eye. It was also considered necessary that the dovetailed groove should be milled so as to make the heads interchangeable.



Jig for Milling and Drilling Sliding Heads of Small Sensitive Drills

Previous to making this jig the castings had been planed a certain distance from the center of the cored hole *A* and this hole had been afterward bored and reamed in a jig which received the planed surfaces. By this method the hole *A* was quite often out of center with the outside of the casting because it was very seldom that the core was placed in its proper position in the mold to insure its being central. To obtain somewhere near satisfactory results it was necessary that the planing should be carefully done and that the sides of the dovetail be equally distant from the center of the hole. Hole *B* for the pinion shaft which feeds the spindle, holes *D D* for the clamping screw and lever, and hole *C* to adjust the tension of the feed sleeve had been laid out by hand and drilled after planing. The excessive cost of finishing the heads by this primitive method had long been a source of worry to the firm and the jig was therefore built with the understanding that it should show a noticeable reduction over the time required by the previous method. It was [illegible] make a very large saving because the jig and [illegible] heavy were not as easily handled as the casting alone, and added to this, was the necessity of keeping both the vertical miller and the drill press tied up on the job. Laboring under these difficulties it was gratifying to note that the first [illegible] came through with an average saving of ten minutes on each casting and also the additional gain in the improved appearance and interchangeability of each head.

The body of the jig, made of cast iron, is finished all over its base, slotted and tongued to fit the milling machine table and cut away at one side to allow for tightening the screw bushing, *F*. The casting is [illegible] in position in the jig by [illegible] bearing against the stationary [illegible]. To take the thrust of the [illegible] the [illegible] *G G* are [illegible] evenly against both [illegible] of the [illegible] by the [illegible] head set-screws shown. [illegible] two steel straps *H H* [illegible] where otherwise it would [illegible] of the clamp. The [illegible] noted, they [illegible] entire length of the [illegible] brought [illegible] movement of the casting [illegible] can occur.

After the casting has been [illegible] properly [illegible] it is placed on the milling machine [illegible] with a cutter of the correct shape. It is then finished level with the top of the steel straps which are used as a gage for setting

the depth of finishing cut on the first casting. The micrometer adjustment on the elevating screw is used for the following castings.

The well-known difficulty of accurately drilling and reaming cored holes has been overcome in this case by the use of a roughing and finishing single pointed boring tool on the holes *A* and *B* before putting through the machine reamer, the finishing boring tool leaving about 0.005 inch for the reamer to take out. It is of course unnecessary to add that the reamer and shank of the boring tool should be a good fit in their respective bushings and likewise that the screw bushing should be a good fit in the jig. The hole *c* having a counter-bored shoulder for a filister head screw is finished before removing the casting from the jig in the following manner: The bushing in the jig is made the size of the head of the screw and a drill of this size is used to spot the hole. It is followed by tap and clearance drill and lastly by a counter bore, which is nothing more than a piece of drill rod of the proper size having teeth cut on the end.

An improved method of fastening together parts of jigs and fixtures is also shown. The steel straps *J J* are fastened to the cast iron body of the jig with hexagon head cap screws the heads of which are sunk below the surface and tightened up with a socket wrench. This necessitates a counterbored hole the size of the outside of the socket wrench but has the advantage over the filister head screw of being able to be set up as tight as a cap screw with a protruding head.

New York. H. J. Bachmann.

AN UNCOMMON LATHE JOB.

Editor Machinery:

A peculiar job came under my notice some time ago. The top portion of a rudder stem had worn very badly and it was decided to have it repaired. The original diameter of the head was about 6 inches, and it had worn down in the socket under the tiller to about 3½ inches. The stem was longer than necessary and instead of cutting the defective part off

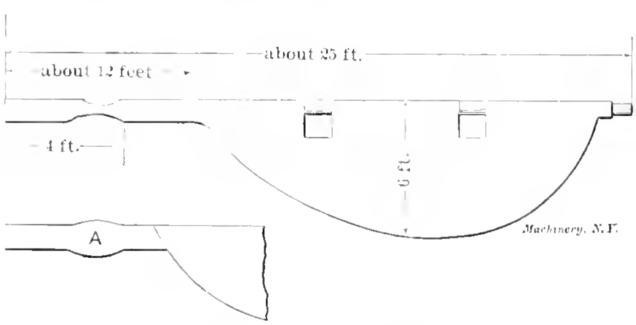


Fig. 2. Rudder Frame, showing Worn Place in Stem.

and welding a new end on, the end was staved up by the blacksmiths until there was sufficient excess metal at the worn part to turn down to the original diameter. The question was how to machine the part that worked in the gland. The sketch, Fig. 2, will better explain the difficulty. The rudder frame was in one piece and had to remain intact. No lathes were available that could swing the rudder between its centers, and the part marked *A* had to be machined fairly true with the main axis of the rudder. The following plan was adopted and proved successful.

The longest lathe available, 28 inches swing and about 18 feet in the bed, was requisitioned, the tailstock removed and all the top gear taken off, the main saddle carrying the tool rest. The rudder was then fastened to the saddle, being lined up as near as possible so that the axis of the rudder would coincide with the line between head and tail centers of the lathe under ordinary conditions. The overhanging portion of

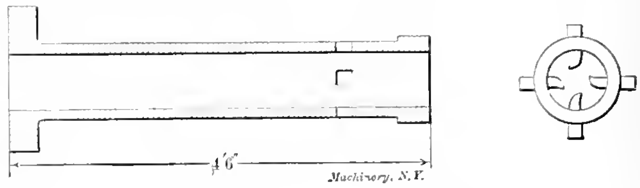


Fig. 3. Cast Iron Pipe, Carrying Cutters.

the rudder was supported by rollers on trestles. A cast-iron pipe as per sketch, Fig. 3, was fixed in the chuck, the flanged end being fastened to the chuck and the tail end trued up on the outside to allow it to run in a V-guide or steady rest. Short cutters were inserted in the four square holes with the cutting edges inside. The saddle was then moved forward, partly carrying and partly dragging the rudder. The feed gear was then set in motion and the swelled end of rudder was steadily carried on through the pipe, the cutters doing their work in the one setting.

Straightedge.

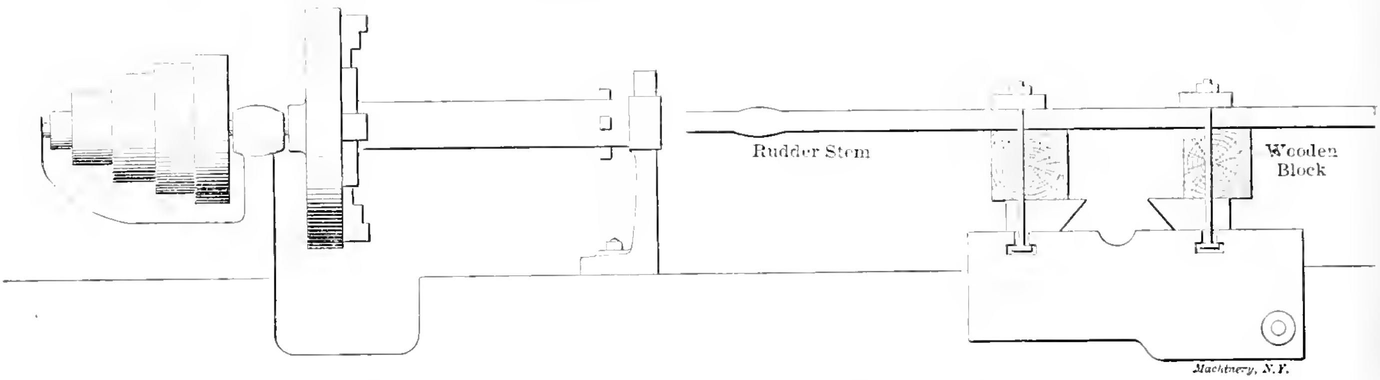


Fig. 1. Method of Arranging Lathe and Work, for Machining Rudder Stem.

COVERING PULLEYS WITH LEATHER.

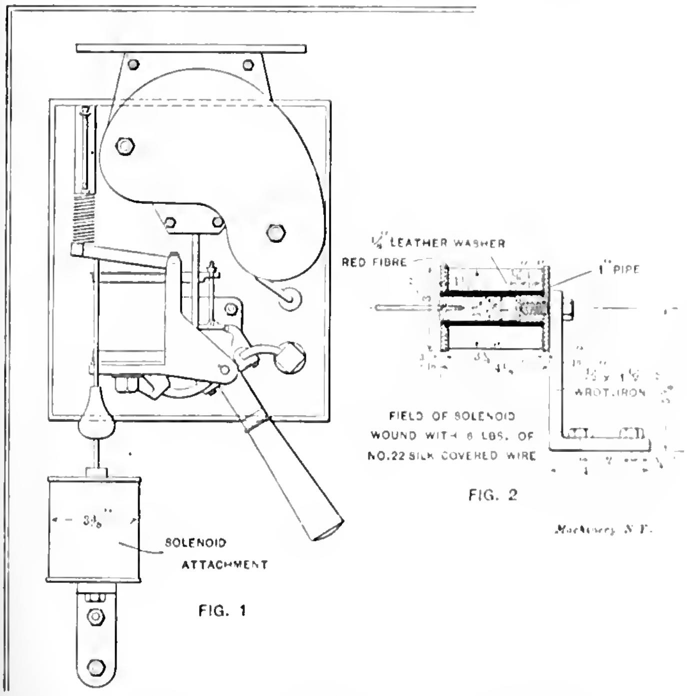
Editor Machinery:

I recently saw a belt, which though tightly strained, slipped badly because the contact with the smooth pulley rim was inadequate to enable the belt to drive the work required of it. The poor performance of duty rendered by this belt and pulley caused me to wonder why such a condition often occurs when it can so easily be corrected by a method that insures the maximum of adhesiveness, i. e., covering the pulley with leather or rubber. Haswell's Engineer's and Mechanic's Pocket Book, 22d edition, states as results of experiments upon the adhesion of india rubber and leather belting by I. M. Cheever that a rubber belt slipped on iron pulleys at 90 pounds; on a leather or leather-covered pulley at 128 pounds; and on a rubber or rubber-covered pulley at 183 pounds. Also that a leather belt slipped on an iron pulley at 48 pounds; on a leather or leather-covered pulley at 64 pounds; and on a rubber or rubber-covered pulley at 128 pounds. It can be seen that the leather-covered pulley greatly exceeds iron in the adhesion of the belt, and rubber gives more adhesion than any other material used on the periphery of pulleys.

I have never used rubber-covered pulleys, but have seen pulleys on which the belts slipped badly, which, when covered with leather, showed such an improvement in the adhesion of the belt that all slipping of the belts stopped. The method of attaching the leather covering in this case was performed as follows: A leather belt the exact width of pulley was fastened to the pulley face by a pair of hand screw clamps placed within one inch of the end of the belt. The belt was stretched and wound around the periphery of the pulley tightly, and the ends lapped. The joint was marked with a sharp knife and the belt was then removed. The pulley face was painted with a coat of good white lead ground in oil, and when the paint had dried somewhat, but was still a little sticky, the face of the pulley and the grained surface of the belt were covered

with a coat of good glue. One end of the belt was then fastened to the pulley face and secured by a screw clamp as before. Then as the belt was tightly wound to its place on the face of the pulley, clamps were tightened as close as they could be applied and screwed up tight. The ends of the belt were brought together and the joint covered with a clamp which was screwed tight. The clamps were left on till the glue was dry and when they were removed the face of the pulley was neatly covered with a leather jacket on which the belt never slipped. The adhesion of the two leather surfaces transmitted the motion of the entire circumference of the pulley at each revolution with nearly the same certainty as gear teeth.

In my own individual experience a man owning a saw mill wished me to prevent his belt from slipping, which it did badly, when the saw was buried deep in a log. The pulley was 24 inches diameter and the saw 60 inches. As the mill was damp and the job in haste, I did not stop to bother with paint and glue but secured the leather covering to the face of the pulley by drilling a row of holes for copper rivets around the periphery, on each edge of the pulley, ⅝ inch from the edge and 2 inches apart; also a row of holes around the center of the pulley 5 inches apart to hold the leather tight to the



Figs. 1 and 2. Circuit Breaker, with Solenoid Attachment

pulley in the center. Two rows were drilled across the face of the pulley to secure the ends of the leather. I placed the heads of the rivets outward, sinking them a little below the surface of the leather with a drift of the same diameter as the rivet heads, hammering them tight on the inside of the pulley rim. On this covering the belt never slipped even when the saw was entirely buried in a log so large that the teeth of the saw did not cut through the top of the log. I instructed the sawyer to tighten the rivets occasionally, and by this simple job a mill that had given much trouble became a source of comfort and profit to the owner and the men who did the work.

Syracuse, N. Y. C. E. Mink.

CIRCUIT BREAKER, WITH SOLENOID ATTACHMENT.

Editor Machinery:

The cut shows a design of circuit-breaker with a solenoid attachment. These circuit-breakers are of a well-known type (General Electric) and are on the circuit of a 100 H. P. motor which drives a lineshaft and to which are belted three large rock crushers. These crushers are at some distance from the switchboard, and as it often happens that the crushers must be shut down quickly, considerable time would be lost in running to the switchboard and throwing the switch. By using this solenoid attachment the motor can be stopped from each crusher by simply throwing a switch.

The solenoid, Fig. 2, is operated by a 250-volt current. When the knives of the switch are thrown together the armature is drawn in and operates the circuit-breakers. After the motor has been stopped the attendant can then throw the switch on the switchboard.

Desloge, Mo. Herbert S. Gladfelter.

RULES FOR FIGURING THE SPEED OF PULLEYS AND GEARS.

Editor Machinery:

A few days ago a machinist of my acquaintance came to me for the purpose of ascertaining the method of finding the proper size of pulley to use to drive at a certain speed a machine which he was erecting. I was a little surprised at his lack of knowledge in the matter but upon second thought I have found from time to time in my experience among mechanics that the rule which seems to me to be very simple is not so generally known as one would suppose. This table will show the notation used in the formulæ:

a = Diameter of driver.
b = Diameter of driven.
c = R. P. M. of driver.
d = R. P. M. of driven.
R. P. M. = Revolutions per minute.

The diameter of driver, R. P. M. of driver, and diameter of driven being given, to find the R. P. M. of driven, then

$$\frac{a \times c}{b} = d$$

The diameter of driver, R. P. M. of driver, and R. P. M. of driven being given, to find the diameter of driven, then

$$\frac{a \times c}{d} = b$$

The diameter of driven, R. P. M. of driven, and diameter of driver being given, to find the R. P. M. of driver, then

$$\frac{b \times d}{a} = c$$

The diameter of driven, R. P. M. of driven, and R. P. M. of driver being given, to find the diameter of driver, then

$$\frac{b \times d}{c} = a$$

To make the rules perfectly clear to apprentices and all others to whom the subject may be new, let us substitute figures in the first formula. Suppose, for example, we have a driving pulley (or driver as termed in the rules) 24 inches diameter, making 300 revolutions per minute, and the driven pulley is 16 inches diameter, then to find the revolution per minute of the driven pulley we have: $\frac{24 \times 300}{16} = 450$ revolutions per minute of driven pulley.

The fundamental principle of the rules, of course, is to multiply the diameter of the pulley by its own revolutions per minute and divide by the other given term to obtain the result, and the same rules may be used in determining the speed of gears by substituting the number of teeth for the diameter. Frederic E. Durfee.

Fall River, Mass.

TO FILE A SHARP SCRIBER.

Editor Machinery:

To file a scriber point take ordinary drill rod of any size desired and catch same in a lathe chuck, leaving say about ¾ or 1 inch projecting. Then with a good sharp smooth file start the point by filing it blunt say at about an angle of 60 degrees, then gradually file the angle sharper and sharper by merely changing the position of the file (which should be at least 1 inch wide) so it stands more and more in a line parallel with the piece being filed. By this method it is possible to get a long slim point, whereas if the file is held at the finished angle to begin with, difficulty arises due to the fact that the file has too much surface to cut and the point gets weak and springy. Finish point by holding on side of good straight emery wheel or disk grinder (while soft) so the grinder marks run from point to back; after hardening, oil stone only.

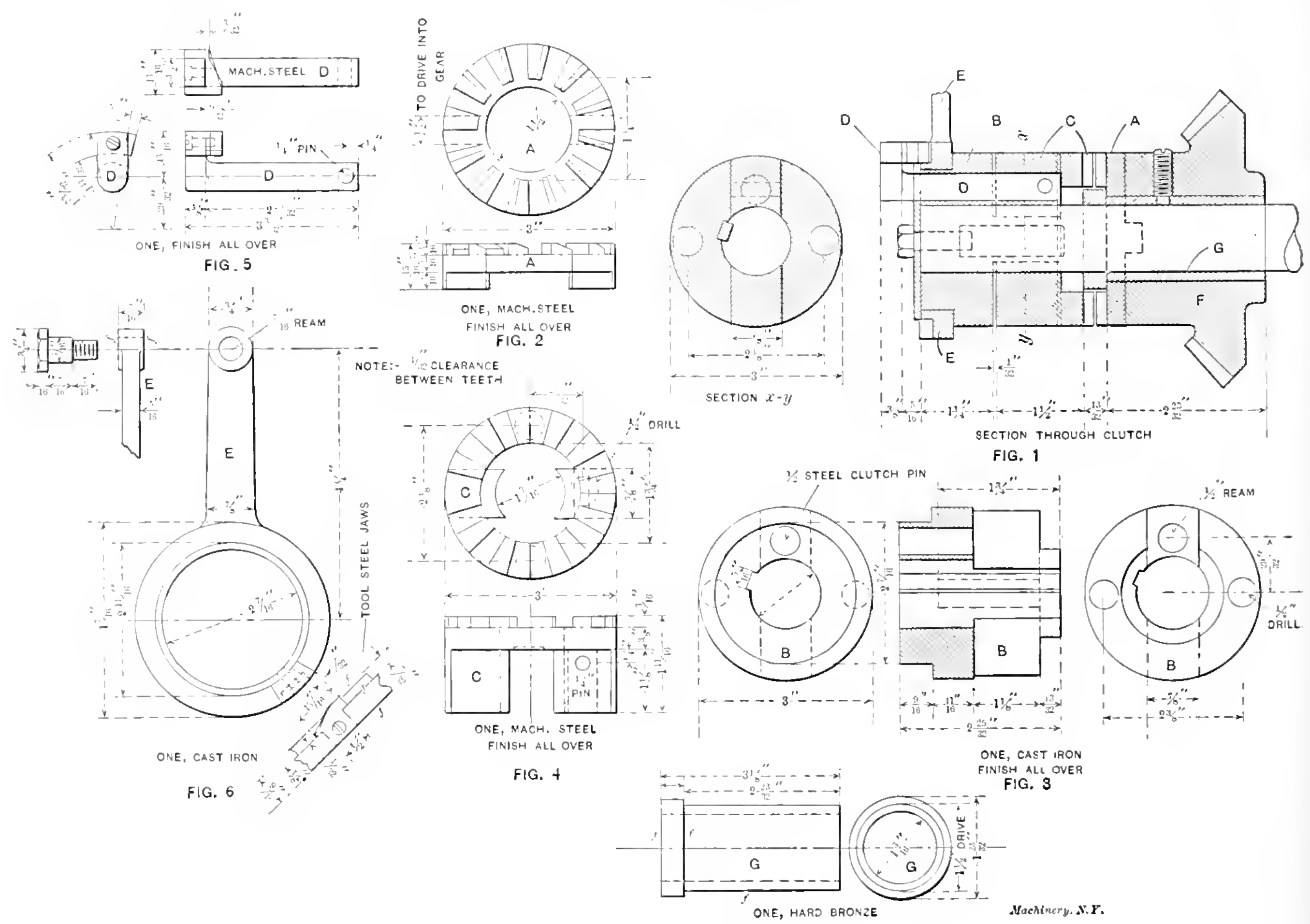
Chicago, Ill. R. A. Lachmann.

ONE-TURN CLUTCH.

John D. Adams.

Editor MACHINERY:

Very often in the design of special machinery, we have certain operations, such as feeding, etc., which are done by hand and which require that certain parts remain at rest during the period. Sometimes this period of rest can be taken care of by intermittent gears or similar device, but when the period of rest is of uncertain duration these are very unsatisfactory. The drawings herewith show a clutch so constructed that by means of a slight movement of a lever it will make exactly one turn (or one-half or quarter turn if so designed) and then stop exactly at the point where it started.



Clutch by which Intermittent Shaft is given Motion of exactly one Turn or Fraction of Turn.

Fig. 1 is a cross section lengthwise of the shaft which has the intermittent motion. The bevel gear, *F*, mounted on the bronze bushing *G*, furnishes the power and runs continually. The circular ring, *A*, Fig. 2, has twelve teeth and is held up against the end of the gear by the brass bushing, *G*. The end of the gear is slotted radially to receive the two lugs on the back of Fig. 2, which cause it to turn with the gear. The piece *B*, shown in detail in Fig. 3, is keyed to the intermittent shaft, and has two slots ⅞ inch wide diametrically opposite to each other. These two slots are to keep the set of teeth shown in *C*, Fig. 4, from turning on the shaft and at the same time to allow them to move forward so as to engage the set of teeth on the end of the bevel gear. This forward motion of Fig. 4 is controlled by the clutch pin, *D*, shown in Fig. 5, also clearly shown in the section view, Fig. 1. This clutch pin passes freely through the ½-inch hole in Fig. 3 and is secured by a ¼-inch pin to one of the lugs on the back of the intermittent set of teeth, *C*, Fig. 4.

The clutch is operated by the lever *E* shown in Fig. 6, which has a slight motion around the end of the block, Fig. 3. When the clutch is at rest the highest point of the inclined plane on the clutch pin, *D*, Fig. 5, rests on the highest point of a similar plane on the controlling lever, Fig. 6. Two coil springs placed in diametrically opposite holes in Fig. 3, press against the back of the intermittent set of teeth, *C*, and keep the two inclined planes just mentioned continually bearing against one another so that when the lever, Fig. 6, is slightly rotated the clutch pin drops off allowing *C* to engage clutch *A*, which rotates the shaft. A spring, not shown, brings the controlling lever back to its original position as soon as the momentary pressure of the hand is released and when the clutch pin, which travels around with the clutch, nearly completes one turn, its inclined plane rides up on the one attached to the controlling lever and the two sets of clutch teeth are pulled apart, thus stopping the motion of the intermittent shaft. At any convenient point around the mechanism to be operated a definite stopping point should be arranged and so connected with the controlling lever that the stopping point and the lever will be moved simultaneously. In this way it is possible to make the clutch stop at precisely the same point every turn. By placing two, three or four inclined planes on the controlling lever the clutch may be made to stop a corresponding number of times each turn.

Phœnix, Ariz. JOHN D. ADAMS.

MR. JOHN D. ADAMS was born in Toronto, Canada. His technical education was acquired in the Toronto Technical School. He at present holds a position with the Department of Interior at Phœnix, Arizona, and prior to this engagement was with Park, Davis & Co., Detroit, Mich. His specialty is automatic machinery.

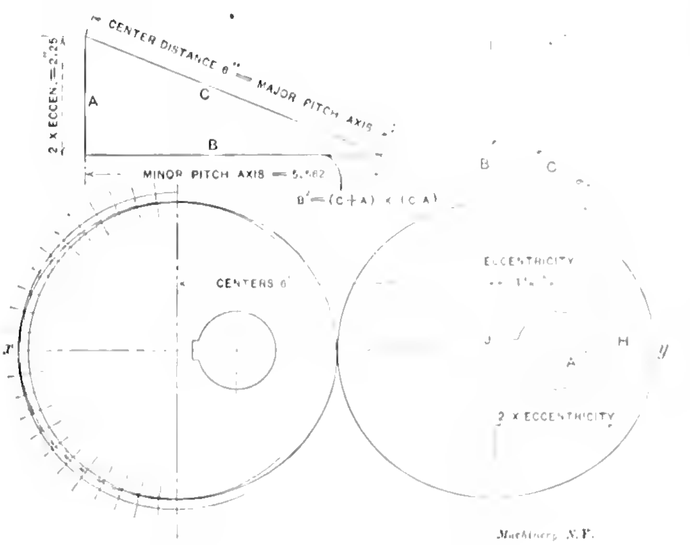
LAYOUT OF PITCH CIRCLES OF ELLIPTIC GEARS.

Editor MACHINERY:

A short time ago it was my pleasure to draw a pair of elliptic gears, and, as very little seems to have been written regarding this style of gearing, perhaps my endeavors may be appreciated. The sketch herewith shows the method employed for laying them out.

The center distance of gears was 6 inches and the eccen-

tricity 1⅛ inches. A horizontal line $x\ y$ is drawn, which represents a center line and the major axes of both gears. Two perpendicular lines which represent the minor axes of the gears are then drawn 6 inches apart; this distance also equals the major pitch diameter, which can be readily spaced off. The minor pitch diameter is obtained graphically by placing a point H a distance of double the eccentricity from the minor axes on the center line, and from this point with a radius equal to the center distance, draw an arc cutting the perpendicular line at J. The distance from I to J equals the minor pitch diameter.



Layout of Pitch Circles of Elliptic Gears

From this we see that the major pitch diameter C = center distance of gears; minor pitch diameter $B = \sqrt{(C+A)(C-A)}$ and eccentricity $E = \sqrt{R^2 - R_1^2}$, where A = double the eccentricity, C = center distance, R = half of major pitch diameter, and R_1 = half of minor pitch diameter.

After obtaining the diameters the ellipse can be drawn by any of the numerous methods. Perhaps the most accurate for any diameters is to point off equal (or unequal) spaces on a circle whose diameter equals the major axis, and through these points draw short radiating lines. From the same center draw another circle whose diameter equals the minor axis. Through the points in the larger circle erect short vertical lines, and where the radiating lines intersect the smaller circle draw horizontal lines.

The intersection of these lines will be points of the ellipse, which can be sketched in free hand or by aid of the compass.

Bridgeport, Conn. C. E. JOSSELYN.

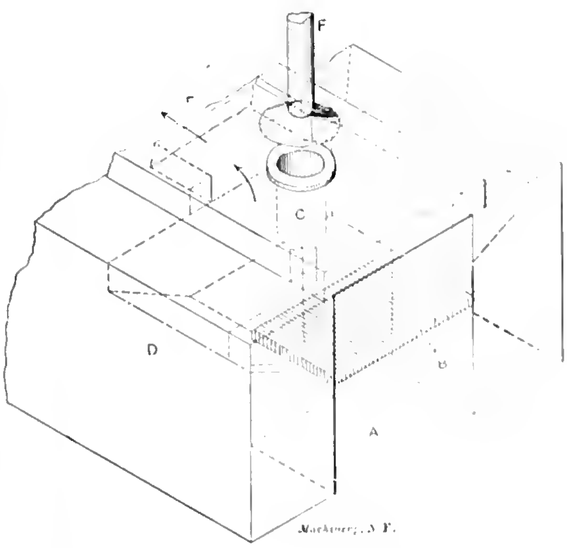


Fig. 1. Coke or Charcoal Furnace for Heating Bath.

HEATING BATHS FOR USE IN STEEL HARDENING.

Editor MACHINERY:

Where it is desired to heat small pieces in melted lead, cyanide of potash or other substance which enables a fore-ordained even temperature to be attained, and which at the same time protects the articles which are to be heated from the oxidizing action of the air more conveniently than is possible by the use of muffles, the furnaces shown in the two annexed illustrations will serve as types.

In Fig. 1 the crucible C is to be heated by mild coke or still better by charcoal, as this gives a more regular heat. The grate must be adapted to the fuel. Where coke is used, a brand should be employed which is known as "extra mild"; otherwise despite the regular nature of the coke fire there might be trouble with overheating, which would entail loss of time in allowing the melted material to cool down to the desired maximum temperature.

The furnace shown in Fig. 2 is intended for either wood, anthracite or soft coal. The temperature of the bath between such points as represent fusion of the solid and evaporation of the liquid is extremely difficult to estimate from the general appearance of the latter, particularly as the apparent color depends on the light of the room in which the furnace stands, on whether the observer's eye is accurate or not, and on whether he has already made several such observations—in which latter case he will be very apt to estimate too low. A good pyrometer will do "yeoman's service" in preventing expensive mistakes.

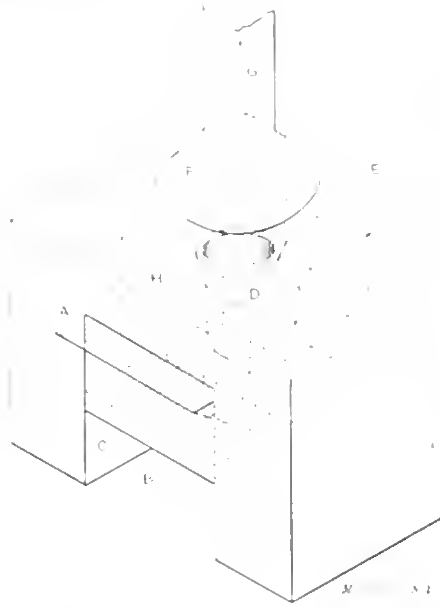


Fig. 2. Wood or Coal Furnace used for Heating Bath

The fumes of the lead are injurious to the health, and those of the cyanide are highly poisonous, therefore, both these must be conducted away by a special inverted funnel, F, Fig. 1; G, Fig. 2, that has a strong natural or artificial draft entirely independent of that of the smoke passage, E, both figures.

In Fig. 2 the firing is done through a hopper, A. The ash pit, C, can be closed by a plate so as to lessen the draft once the fire on the grate B has caught.

Hanover, Germany. ROBERT GRIMSHAW.

TABLES GIVING ANGLES OF THREADING TOOLS.

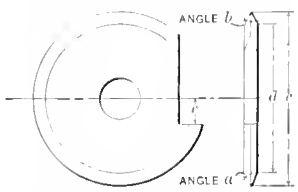
Editor MACHINERY:

Herewith I contribute three sets of tables which may be of interest to some of your readers. The first table in question deals with the circular threading tool. This kind of a tool most generally has its cutting face below its center line which, of course, changes the angles. It not only changes the angles, but as we lower the cutting edge, the same becomes a convexed line. On large diameters this second error is not noticeable to any extent, although it exists from the very moment we lower the cutting face of such a tool. This

one item makes it very difficult to accurately give the reader the angle to make such a tool, which should cut an accurate 60 degree thread, when the tool is cut a certain amount under its center line.

The angles given in Table No. 1 were computed by the writer taking diameter d to be ⅛ inch smaller than c; this difference was used throughout the tables. The first column gives the largest diameter of tool, while the second gives the diameter from which the following angles were obtained. The eight columns following give the angle of one side of tool and also the included angle for such tools which have their cutting face ⅛, 3-16, ¼ and 5-16 inch below the center line.

TABLE NO. 1. CIRCULAR THREADING TOOLS.



a = ANGLE WITH SIDE OF TOOL
b = INCLUDED ANGLE OR 2 × ANGLE a
c = LARGEST DIAM. OF TOOL
$d = c - .125$ (THESE TABLES WERE COMPUTED FROM THIS RATIO)
e = DISTANCE FROM CENTRE LINE TO CUTTING FACE

LARGEST DIAM. OF TOOL $=c$	DIAM. $d = c - .125$	ANGLES ON CENTRE LINE WHEN $e = .125$		ANGLES ON CENTRE LINE WHEN $e = .1875$		ANGLES ON CENTRE LINE WHEN $e = .250$		ANGLES ON CENTRE LINE WHEN $e = .3125$	
		ANGLE a	ANGLE b	ANGLE a	ANGLE b	ANGLE a	ANGLE b	ANGLE a	ANGLE b
¾	⅝	31° 41′	63° 22′	34° 38′	69° 08′	40° 10′	80° 20′		
⅞	¾	31 15	62 30	33 05	66 10	36 18	72 36	42° 25′	84° 50′
1	⅞	30 56	61 52	32 13	64 26	34 20	68 40	37 50	75 40
1⅛	1	30 43	61 26	31 41	63 22	33 13	66 26	35 34	71 08
1¼	1⅛	30 34	61 08	31 19	62 38	32 29	64 58	34 12	68 24
1⅜	1¼	30 28	60 56	31 04	62 08	31 59	63 58	33 18	66 36
1½	1⅜	30 23	60 46	30 53	61 46	31 37	63 14	32 40	65 20
1⅝	1½	30 19	60 38	30 45	61 30	31 22	62 44	32 13	64 26
1¾	1⅝	30 17	60 34	30 38	61 16	31 09	62 18	31 52	63 44
1⅞	1¾	30 11	60 28	30 32	61 04	31 00	62 00	31 36	63 12
2	1⅞	30 13	60 26	30 29	60 58	30 52	61 44	31 23	62 46
2⅛	2	30 11	60 22	30 25	60 50	30 45	61 30	31 13	62 26
2¼	2⅛	30 10	60 20	30 22	60 44	30 40	61 20	31 04	62 08
2⅜	2¼	30 09	60 18	30 20	60 40	30 35	61 10	30 57	61 54
2½	2⅜	30 08	60 16	30 18	60 36	30 32	61 04	30 51	61 42
2⅝	2½	30 07	60 14	30 16	60 32	30 29	60 58	30 46	61 32
2¾	2⅝	30 06	60 12	30 14	60 28	30 26	60 52	30 42	61 24
2⅞	2¾	30 06	60 12	30 13	60 26	30 24	60 48	30 38	61 16
3	2⅞	30 05	60 10	30 12	60 24	30 22	60 44	30 34	61 08
3⅛	3	30 05	60 10	30 11	60 22	30 20	60 40	30 32	61 04
3¼	3⅛	30 04	60 08	30 10	60 20	30 18	60 36	30 29	60 58
3⅜	3¼	30 04	60 08	30 09	60 18	30 17	60 34	30 27	60 54
3½	3⅜	30 04	60 08	30 09	60 18	30 16	60 32	30 25	60 50
3⅝	3½	30 03	60 06	30 08	60 16	30 15	60 30	30 23	60 46
3¾	3⅝	30 03	60 06	30 08	60 16	30 14	60 28	30 22	60 44
3⅞	3¾	30 03	60 06	30 07	60 14	30 13	60 26	30 20	60 40
4	3⅞	30 03	60 06	30 07	60 14	30 12	60 24	30 19	60 38

Machinery, N.Y.

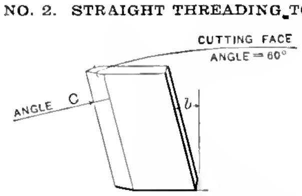
Should one desire to construct such a tool for very coarse threads, say, for instance 2 or 3 pitch, he can readily do so with very accurate results by simply manipulating the figures in the table. Example: A circular tool is to be made, of which the extreme diameter is to be 2 inches and which is to be used for cutting 2-pitch threads; its cutting face is to be 5-16 inch below the center line, and it must cut to the depth of 0.433 inch when the top width of cut equals 0.500 inch. Now the table gives us for a 2-inch diameter 60-degree tool cut 5-16 inch below center, the half angle 31° 23′, or 62° 46′ included angle. These angles would be accurate for making a tool that was to be used on threads that have an approximate depth of about 1-16 inch, but for the tool in question we would come nearer right if we reckoned our two diameters, namely, 2 inches for the one and 1⅛ inches for second diameter, since $2 \times 0.433 = 0.866$, which is nearly ⅞ inch and 2 inches—⅞ inch would equal 1⅛ inches for the second diameter. Now if we consider the intermediate diameter 1 9-16 inches—which is found as follows: 2 — 1⅛ = ⅞ inch; ⅞ ÷ 2 = 7-16 inch; 7-16 + 1⅛ = 1 9-16 inches—we find upon referring to the tables that a 1 9-16-inch diameter is not given, so we divide the difference between a 1½-inch and 1⅝-inch diameter; this difference is 27 minutes, half of which would be about 14 minutes. This added to the angle given in the 1⅝-inch line would equal 32° 27′, which would be the proper angle to make such tool.

We will now turn to the straight threading tool, which in one sense of the word is a more accurate tool than the circular variety, simply because we have not the convexed side to contend with. The cutting edge of a straight tool is always a straight line (provided it is made accurately) regardless of what the clearance angle is, although we have the same problem to contend with in this style of tool as in the circular variety, namely: when the cutting angle equals 60 degrees, for example, what is the angle on forward side of tool?

Table No. 2 gives this information. As will be seen in this table, the first column gives the clearance angles which range from 8 to 20 degrees, inclusive. In the second and third columns are the respective single and included angles, which when measured on the forward side of the tool will coincide with a perfect 60-degree angle on the cutting face.

There is still another item which is of no less importance than any previously mentioned, and which concerns both the straight and circular threading tools, and that is the setting of such tools in the machine so that they may stand in alignment with the angle of the thread that is being cut. Many threads are cut which are smooth on one side and rough on the other; the cause is not having an equal amount of clearance on each side of the threading tool. For instance, take any style of cutting tool which has two or more cutting teeth and clear the ones that work on one-half of the circle more than the other half, and the result will always be unsatisfactory. This is especially noticeable on turret forming tools of a screw machine. The old style of lathe tool which was used for threading purposes has a little advantage over the circular and straight tools in this item, because they have clearance both ways, but with such tools that can be ground without changing their form, we must obtain one clearance from the forward side only. This makes it more essential to have these tools stand as near in line with the angle of the thread as possible. But when we speak of setting such tools perfectly in alignment with the angle of a thread, we have an impossibility to contend with, because the root of a thread is always smaller in diameter than the apex and as the lead on both root and apex remains the same, the angle must of course change, when going from one diameter to another. In other words, the angle of the spiral at the root diameter is always greater than at the apex of thread. Now to compute our angle. I suppose the most correct diameter to select would be about midway

TABLE NO. 2. STRAIGHT THREADING TOOLS.



ANGLE b = CLEARANCE ANGLE OF TOOL	ANGLE C = ANGLE MEASURED ON FORWARD SIDE OF TOOL. C = ANGLE WITH CENTRE LINE	C = INCLUDED ANGLE
8	30° 15′	60° 30′
9	30 18	60 36
10	30 23	60 46
11	30 28	60 56
12	30 33	61 06
13	30 39	61 18
14	30 45	61 30
15	30 52	61 44
16	30 59	61 58
17	31 07	62 14
18	31 16	62 32
19	31 25	62 50
20	31 34	63 08

between the root and apex of thread, but as the changes of angles are very slight, and really too slight to practically work to, the writer has constructed Table No. 3 which was computed from the diameter over the apex of the thread. This table fills the want very well as it gives the angles of all the threads that are in every day use on diameters which range from 1-16 inch to 6 inches. The accompanying formula can be used if one wants to figure out any other special pitch on diameter which is not contained in the table. When cutting double or triple threads all one needs to do is multiply the given angle by two or three, as the case may be. This table facilitates matters when making tools for cutting square

threads; it also comes in very handy when making tools for cutting spiral springs from the solid, which are so extensively used on sub-press die work.

JOS. M. STABEL.

Rochester, N. Y.

"A BLUFF THAT WENT."

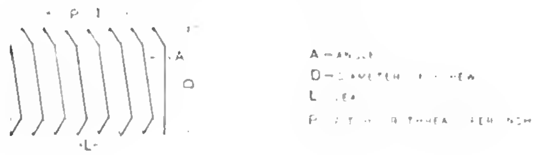
Editor MACHINERY:

Sam was the boss of the plating-room at the lock shop. It was a small shop, and it wasn't much of a job, but then Sam wasn't much of a plater, so he fitted in first-rate. He got eighteen straight per week, and that was good money down there. But one morning Sam went down to the shop to find the plant burned down and a month's pay due him, and no show of getting it until the shop started again. What to do in the meanwhile was the question. Now Sam was well acquainted with the house which had furnished the lock company saw it, and they had pushed him harder than flesh and [illegible] could stand, and one day he got on his ear and lit out. The firm said they thought they could save his wages by letting the oldest boy run the room; said it had worked fine for a while, but now the work was coming rough and it would peel off in spots.

The "super," who was also the owner, took Sam into the plating room at once, and showed him the work, and it did look bad. Sam looked the room over pretty well, and then put his hydrometer into the bath and tried his litmus paper to see if the solution was right. It was O. K. and Sam knew at once that the fault was in the potash. He never let on a word, but gravely dipping his hand in the solution and letting it drop off his fingers (a test by the way, that no man can tell a thing by) said: "Yes, the tubs are in a bad shape, and it will be a job to save them, but I can do it all right."

TABLE NO. 3. DIAMETERS WITH CORRESPONDING ANGLES OF THREADS.

TO FIND ANGLE A $\dfrac{\text{LEAD}}{\text{CIRCUMFERENCE OF SCREW}}$ = TANG. OF ANGLE



THREADS PER INCH	DIAMETERS WITH CORRESPONDING ANGLES																		
	1/16	1/8	3/16	1/4	1/2	3/4	1	1¼	1½	1¾	2	2½	3	3½	4	4½	5	5½	6
100	2° 55'	1° 27'	58'	44'	22'	15'	11	09	07	06	05								
80	3 39	1 49	1 13	55	27	18	14	11	09	08	07	05							
64	4 31	2 17	1 31	1 08	34	23	17	14	12	10	08	07	06	05					
56	5 12	2 36	1 44	1 18	39	26	19	16	13	11	10	08	07	06	05				
48	6 04	3 02	2 02	1 31	46	30	23	18	15	13	12	09	08	07	06				
40		3 40	2 31	1 49	55	37	27	22	18	16	14	11	09	08	07	[illegible]	05		
36		4 02	2 42	2 02	1 00	40	30	24	20	17	15	12	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
32		4 33	3 02	2 17	1 08	46	34	27	23	19	17	14	12	10	[illegible]	[illegible]	[illegible]	[illegible]	
30		4 51	3 14	2 27	1 13	49	37	29	24	21	18	15	12	11	09	[illegible]	[illegible]	[illegible]	06
28			3 28	2 36	1 18	52	39	31	26	22	19	[illegible]	[illegible]	11	10	[illegible]	[illegible]	[illegible]	[illegible]
26			3 44	2 48	1 24	56	42	34	28	24	21	[illegible]	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]	[illegible]
24			4 03	3 02	1 31	1 00	46	37	30	26	[illegible]	18	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]	[illegible]
22			4 25	3 19	1 39	1 06	50	40	[illegible]	28	25	20	17	[illegible]	[illegible]	11	10	[illegible]	[illegible]
20				3 38	1 49	1 13	55	44	37	31	27	22	18	16	14	12	11	10	[illegible]
18				4 03	2 02	1 21	1 00	49	41	35	30	24	20	[illegible]	[illegible]	14	[illegible]	11	[illegible]
16				4 33	2 17	1 31	1 08	55	46	39	34	27	[illegible]	20	[illegible]	[illegible]	14	[illegible]	11
14				5 12	2 36	1 44	1 18	1 01	52	44	39	31	[illegible]	[illegible]	19	[illegible]	[illegible]	14	[illegible]
13				5 36	2 48	1 52	1 21	1 05	56	48	42	34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14
12				6 01	3 02	2 01	1 31	1 13	1 00	52	46	37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11				6 38	3 19	2 12	1 39	1 20	1 06	56	50	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10				7 16	3 38	2 26	1 49	1 27	1 13	1 02	55	44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9				8 08	4 04	2 42	2 02	1 38	1 21	1 10	1 00	[illegible]	40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8				9 08	4 34	3 02	2 17	1 49	1 31	1 18	1 08	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7					5 12	3 28	2 36	2 01	1 44	1 28	1 18	1 01	[illegible]	44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6					6 04	4 02	3 02	2 26	2 01	1 44	[illegible]	[illegible]	1 00	[illegible]	[illegible]	41		[illegible]	
5½					6 38	4 24	3 19	2 40	2 12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5					7 16	4 52	[illegible]	[illegible]	[illegible]	2 04	[illegible]	1 27	[illegible]	1 02	[illegible]	[illegible]	[illegible]	[illegible]	
4½					8 05	5 21	4 04	3 16	2 42	2 20	2 02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4					9 08	6 04	4 34	[illegible]	3 02	2 36	2 17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3½						6 56	5 12	4 02	[illegible]	2 56	2 36	2 01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3¼						7 28	5 36	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3						8 04	6 01	4 52	4 02	[illegible]	3 02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2⅞						8 26	6 20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2¾						8 48	6 38	[illegible]	4 24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2⅝						9 20	6 56	[illegible]	4 16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2½							7 16	5 48	[illegible]	4 08	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2⅜							7 42	6 10	[illegible]	4 24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2¼							8 08	6 32	[illegible]	4 40	4 04	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2							9 08	[illegible]	6 04	5 12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

with their plater's supplies, and he sent them a letter telling just how the case stood, and asked them if they could fling a job his way. An answer came back in three days with a special delivery stamp on the letter, telling him to go to The Country Hardware Company, that they had had a row with their plater, and he had "jacked up" and left them. They were in a fix and wanted a man bad.

The letter didn't say so, but Sam got the idea that the firm was not over liberal on the pay-roll end, but it was not a time for him to be "squeamish," so up he went. Well, it was a little backwoods place run by water-power. The shop was down in a hollow on the edge of a pond, and the boys could fish out the plating-room window when they got their vats full. The case was like this: They had a good man and he was a worker too, but the firm didn't know a good thing when they

"Well- what wages do you want?" asked the "super."

Now Sam had learned that the last man had run the room for about one-half of what it was worth, so he thought the concern should pay for all that they had coming this time, and he set his price at $24.00 per week. The "super" nearly fell off the stool. "What! $24.00?" said he. "Why we only paid our last man $12.00, and he didn't earn that; he used to sit round the room half the time and let the boys do the work."

"All right, if you want a cheap man get him: the woods are full of them but if you let those tubs run a week more, no man can save them, and you know what a new lot of acid would cost you. That solution is worth twenty cents a gallon, and you have about five thousand gallons there." That settled it; and Sam was hired at his own price.

He pulled off his coat and went to work. The old potash

was very dirty and Sam mixed up a new lot, and told the boys to dip the work well. The first lot came out of the bath in fairly good shape, a few pieces peeled a trifle, but the next lot came O. K., and Sam had no trouble after that. He stayed until the lock shop was rebuilt and then went back to his old job. Sam told me this himself, and while he has his faults, breaking the ninth commandment is not one of them.

A. P. PRESS.

A CRITICISM.

Editor MACHINERY:

In his article, "An example of worm gearing" in last issue of MACHINERY, Mr. Perrigo finally gets to the point where he shows us his method of sizing worm gears, and the proofs that he advances to show its superiority over other methods are certainly startling, for instead of comparing the behavior of worm gears constructed by his and by other methods, he simply informs us that his worm gears gave satisfaction, perhaps in spite of his method for sizing them. I am not prepared to say that there is nothing in Mr. Perrigo's method, but after reading his proofs I have a strong inclination to think so.

The angle of thread of the worm is likely to have a far greater effect on the behavior of worm gearing than slight differences in the size of the worm gear. If we had been informed about the diameter of the worm, lead or number of threads to the inch, number of revolutions per minute, pressure, etc., we would have been in a position, perhaps, to learn something from the article.

In Brown & Sharpe's "Practical Treatise on Gearing," the method of assuming the pitch diameter of the worm gear from the point where the pitch line of the worm intersects the center line of the worm and worm gear is favored, and adding 2 × addendum for finding the throat diameter. For worm gears with less than 30 teeth, they give a rule for finding throat diameter which, written as a formula, would take the form:

$T = .937D + 4S$, in which

T = throat diameter,

D = pitch diameter,

S = addendum.

Now for comparison let us see what size of worm gear or throat diameter T we get by the first and second methods, and by Mr. Perrigo's method, for a worm gear with 28 teeth, 1.25-inch circular pitch, $S = 0.4$ inch.

1. $T = \dfrac{28 \times 1.25}{\pi} + 2 \times S = 11.14 + 2 \times .4 = 11.94$ inches.

2. $T = .937D + 4S = .937 \times 11.14 + 4 \times .4 = 12.05$ inches.

3. Making a layout according to Mr. Perrigo's method, we will find that $T = 11\frac{5}{8}$ inches, thus making T considerably less than by either of the other methods. In this layout the pitch diameter of worm was assumed to be 3.609 inches. In absences of more information about the relative merits of Mr. Perrigo's method, I hold that the first two methods are more reliable.

E. KWARTZ.

Chicago Heights, Ill.

Reply by Mr. Perrigo.

Editor MACHINERY:

Mr. E. Kwartz goes to considerable trouble to criticise my article on worm gears in the June issue, and to tell us several things about worm gear methods that many mechanics are already familiar with, and which many of them use. While he favors other methods in preference to the one given by me, it will be noticed that he does not present any actual evidence of their practical value. The doctors have a saying that "an ounce of prevention is worth a pound of cure," and I want to remind our Chicago friend that an ounce of success is worth a pound of theory, and also, that his fling that the worm gears on the machine referred to "give satisfaction in spite of the method of sizing them," is in my opinion a rather cheap substitute for argument.

Mr. Kwartz further says: "The proofs he advances to show its superiority over other methods are certainly startling, for instead of comparing the behavior of worm gears constructed by his and by other methods he simply informs us that his worm gears give satisfaction," which is only another way of saying that I have simply told the truth. In comparing the two methods discussed, Mr. Kwartz says that my method makes the throat diameter "considerably less," which is neither very definite, nor very conclusive. He concludes thus: "In the absence of more information about the relative merits of Mr. Perrigo's method, I hold that the first two methods are more reliable." If Mr. Kwartz had written me for information in this matter, I would have been pleased to have given him the information desired on this point, or any other relating to mechanical engineering that I could favor him with so that he might present a reasonable argument against an actual fact.

The gist of the matter is just this. I prefer to use a method that I have found by years of practice to result in success. I have made the statement of an actual and easily established fact. If Mr. Kwartz, or any other mechanic desires to use any other method he has a perfect right to do so. Let him have and enjoy his own opinion, but meantime I shall hold mine as long as I have the argument of practical success to back it.

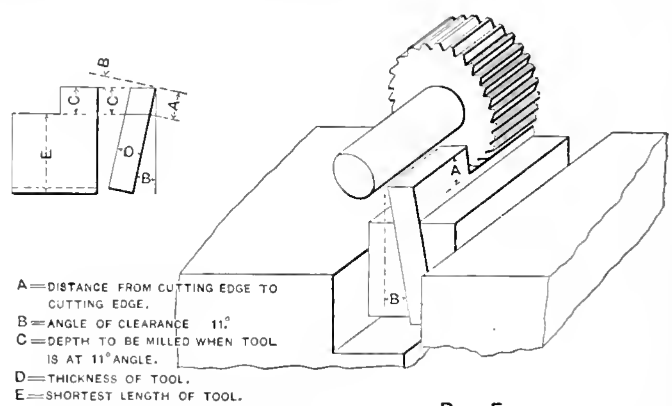
OSCAR E. PERRIGO.

Neponset, Mass.

MILLING FLAT FORMING CUTTERS.

Editor MACHINERY:

The cut and tables of dimensions attached show how we mill flat forming cutters so as to compensate the angular cut necessary for clearance; in other words, how the cutters are measured so that they will cut the actual dimensions required of the screw machine product. The sketches and data are gotten up for the shop in the form of a sheet, 9 x 12 inches. headed "Flat Forming Cutters: Rule for Milling." Follow-



	D	E
SMALL PRATT & WHITNEY SCREW MACHINE & B. & S.	1/4"	3/4"
1 3/8"—WARNER & SWASEY " "	3/8"	1 5/16"
2"—WARNER & SWASEY " "	3/8"	1 5/16"
JONES & LAMSON " "	1/2"	2"

Milling Flat Forming Cutters.

ing is the table at the bottom of the sheet, giving, for the inch and fractions of the inch, the differences between the distance A and the actual depth of the cut C:

$C = A$ minus .01837 for every inch;

$C = A$ minus .00183 for every 1-10 inch;

$C = A$ minus .00018 for every 1-100 inch;

$C = A$ minus .00229 for every 1-8 inch;

$C = A$ minus .00114 for every 1-16 inch;

$C = A$ minus .00028 for every 1-64 inch;

Detroit, Mich. W. E. GOULD.

* * *

LOCOMOTIVES AS FOG-MAKERS.

An engineer asserts that the London fogs are caused largely by the discharge of steam into the air from the 300 or more locomotives operating in the London area. Averaging each engine at 500 horsepower, or a total of, say, 150,000 horsepower, and adding 500,000 horsepower from other steam-generating sources, gives a total of 650,000 horsepower of steam discharged into the atmosphere. One steam plant of 2,000 horsepower, the engineer figures, will discharge into the air twenty tons of steam per hour, or sufficient to produce a fog twenty feet thick and one mile square; and what plants with a capacity of 650,000 horsepower can do in the way of fog production may, therefore, be easily estimated. The proposed remedy is to convert this waste steam into electric power.—*Railway Age.*

HAND TAPS WITH STANDARD THREADS.

H D

In the following is a complete set of empirical formulas and a table for well proportioned hand taps, insuring uniformity as well as a neat appearance.

It will be noted that the formulas are based upon the diameter of tap, this being the most convenient working factor, as, of course, the diameter is always given from the beginning. At the first glance an observer might infer that the working factor ought to be the number of threads per inch, but as that number in all standard systems is dependent upon and stands in a certain relation to the diameter this latter factor is just as correct to work from, and gives simpler and more universal formulas.

It is obvious that formulas cannot be made up that would suit the whole range of diameters from the very smallest up to the very largest, and, therefore, it has been necessary to divide the series in two groups in order to obtain correct proportions, the one group including taps from 3/16 inch up to 1 inch diameter; the second from 1 1/8 up to 4 inches diameter.

In the following formulas:

a = the total length of tap,
b = the length of thread,
c = the length of shank,
d = the diameter of tap,
e = the diameter of shank,
f = the size of the square,
g = the length of the square.

TABLE OF HAND TAPS WITH STANDARD THREADS

Diam. of Tap.	Total Length.	Length of Thread.	Diameter of Shank. U. S. Standard Thread.	Standard V-thread.	Whitworth Standard Thread.	Size of Square.	Length of Square.
3/16	2 1/4	7/8	3/16	3/16	3/16	1/8	3/16
1/4	2 1/2	1	1/4	1/4	1/4	3/16	1/4
3/8	2 15/16	1 1/4	.28	.25	.28	7/32	11/32
1/2	3 3/8	1 1/2	.39	.34	.38	9/32	7/16
5/8	3 13/16	1 3/4	.49	.45	.49	3/8	9/16
3/4	4 1/4	2	.61	.56	.61	15/32	5/8
7/8	4 11/16	2 1/4	.72	.67	.72	9/16	23/32
1	5 1/8	2 1/2	.82	.77	.82	5/8	13/16
1 1/8	5 1/2	2 5/8	.91	.85	.92	11/16	7/8
1 1/4	5 13/16	2 3/4	1.01	.98	1.04	3/4	15/16
1 3/8	6 1/8	2 7/8	1.13	1.07	1.14	27/32	31/32
1 1/2	6 3/8	3	1.26	1.19	1.26	15/16	1
1 5/8	6 11/16	3 1/8	1.37	1.26	1.34	1	1 1/16
1 3/4	6 15/16	3 1/4	1.47	1.38	1.47	1 1/8	1 1/16
1 7/8	7 1/4	3 3/8	1.59	1.47	1.57	1 3/16	1 1/8
2	7 1/2	3 1/2	1.69	1.59	1.69	1 1/4	1 3/16
2 1/8	7 13/16	3 5/8	1.81	1.72	1.82	1 11/32	1 3/16
2 1/4	8 1/16	3 3/4	1.94	1.84	1.91	1 7/16	1 1/4
2 3/8	8 3/8	3 7/8	2.03	1.97	2.03	1 17/32	1 5/16
2 1/2	8 5/8	4	2.15	2.04	2.15	1 5/8	1 5/16
2 5/8	8 15/16	4 1/8	2.28	2.17	2.28	1 23/32	1 3/8
2 3/4	9 3/16	4 1/4	2.40	2.29	2.36	1 13/16	1 7/16
2 7/8	9 1/2	4 3/8	2.48	2.42	2.48	1 27/32	1 7/16
3	9 3/4	4 1/2	2.60	2.48	2.61	1 31/32	1 1/2
3 1/8	10 1/16	4 5/8	2.73	2.61	2.73	2 1/16	1 9/16
3 1/4	10 5/16	4 3/4	2.85	2.73	2.86	2 1/8	1 9/16
3 3/8	10 5/8	4 7/8	2.95	2.81	2.96	2 7/32	1 5/8
3 1/2	10 7/8	5	3.08	2.94	3.08	2 5/16	1 11/16
3 5/8	11 3/16	5 1/8	3.20	3.06	3.20	2 13/32	1 11/16
3 3/4	11 7/16	5 1/4	3.29	3.15	3.33	2 15/32	1 3/4
3 7/8	11 3/4	5 3/8	3.42	3.27	3.44	2 9/16	1 25/32
4	12	5 1/2	3.51	3.40	3.55	2 5/8	1 13/16

For taps from 3/16 to 1 inch diameter the following formulas are to be used:

$a = 3.5d + 1\frac{5}{8}$ inches,
$b = 2d + \frac{1}{2}$ inch,
$c = 1.5d + 1\frac{1}{8}$ inch,
e = root diameter of thread — .01 inch,
$f = \frac{3}{4}e$,
$g = \frac{3}{4}d + 1/16$ inch.

For taps from 1 1/8 to 4 inches diameter the following formulas are to be used:

$a = 2.25d + 3$ inches,
$b = d + 1\frac{1}{2}$ inches,
$c = 1.25d + 1\frac{1}{2}$ inches,
e = root diameter of thread —.02 inch,
$f = \frac{3}{4}e$,
$g = d/3 + \frac{1}{2}$ inch.

In the tables the values have been given in [illegible] in cases where the formulas would give values in the [illegible] inch. This has been done everywhere except in the [illegible] the diameter of the shank, e, where the value figured from the formula has been given in the nearest smaller one-hundredth inch. The shanks of 3/16 and 1/4 inch taps are usually made same as the diameter of the tap.

It is well known that hand taps are made in sets of three, taper, plug and bottoming. They are generally made as follows: The point of the taper tap is turned down to the diameter at the bottom of the thread or a few thousandths smaller, according to the size and pitch of the tap. This acts as a guide and aids in securing a straight tapped hole. This guide ought to be about the length of three or four threads. From the upper end of this guide the thread is tapered until it reaches the full diameter of the tap. The length of this tapered portion is from 6 to 7 threads. The plug and bottoming taps are practically the same, the only difference being that the former has a chamfer of about three threads and the latter of about one thread at the point; the diameter of the straight portion of all the taps in the set is the same.

However, from a critical point of view this way of making taps intended to be used in sets cannot be considered correct, because, as the taps have all the same diameter, the tapered portion of the first tap will have the bulk of the work to do while the two following taps practically have no work to do except in a case where a full thread is required at the bottom of a hole; but even then the duties of the different taps in the set is rather unevenly distributed.

For this reason it is very obvious that taps intended for use in sets should vary in diameter, so that each tap will have a reasonable amount of work to do; of course, the last tap, being a finishing tap, should have less work to do than the two first ones. This way of making hand taps in sets, although being both for practical and theoretical reasons the only correct and the best way, does not seem to have met with the favor of the tap manufacturers, there being only one leading firm (the Pratt & Whitney Co.) who manufacture hand taps made in this manner.

The principal objection to making hand taps in sets as described above, and the probable cause for their slow introduction, must be, that when using taps of such description the whole set always has to be used, whereas for a short hole to be tapped clear through a piece the taper tap alone will be found sufficient, if the straight portion of the tap is up to the full diameter. And in fact, all three taps, when made all with the same diameter, are seldom used except when a full thread is wanted at the bottom of a hole. However, to cut the full thread of a hole tapped clear through a piece by the taper tap in one operation places an undue stress on this tap, and will not give as smooth a thread as if the hole had been run through by a set of taps, each of which cuts a fair amount of the thread, by means of the difference in diameter of the different taps.

In this connection it may be well to mention another quite as important factor in the making of hand taps—the fluting. Both a strong, an easily made, and easy working tap is always looked for. These three factors are greatly dependent upon the way the tap is fluted. It has become more and more the practice in manufacturing taps to make a deep straight-sided flute with a small round of about one-eighth the diameter of the tap at the bottom. This, however, although it has its advantages in providing for more chip-room, has some very grave disadvantages. The tap will crack more easily in hardening, will not cut as freely, and is not as strong as one fluted with a regular convex cutter.

In regard to the number of flutes there is some difference in opinion. There are those who consider four flutes the proper number to use on all sizes of hand taps with the land about one fourth the diameter of the tap. However, on large taps the land will be rather wide if made according to this rule, and better results will be obtained by increasing the number of flutes for those diameters which are larger than 2 inches.

* * *

Sir Wilhelm Siemens announces a new use of vanadium in an electric glow lamp.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A POINTER ON FILING.

In order to make it easy to see the part being filed on work, such as backing off the teeth of small milling cutters and of a like nature, I have been in the habit of using copperas or blue vitriol solution, which as we all know, gives a rather light copper color, but have recently adopted the idea of drawing the piece to be filed to a dark blue over a Bunsen burner. It is needless to say the contrast between the dark blue and the filed parts is very marked—it can't be beat.

Chicago, Ill. R. A. LACHMANN.

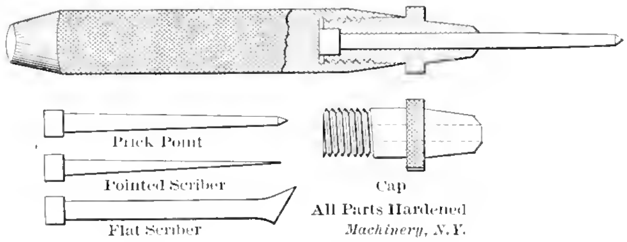
APPLYING ASBESTOS.

Asbestos is of such common use around the steam plant that a knowledge of quick and neat methods of putting it on is sure to be of service. The following meets this requirement: Mix the asbestos thoroughly with water so as to make it plastic; put first coat on rough with pointed trowel about ½-inch thick; after this is dry put on a second coat ¾-inch thick, and straighten down with large trowel. The second coat should be wired by winding with No. 16 annealed wire, the winding to be about 3 inches apart; or in case of flat surfaces, by binding it with horizontal wiring. Apply third coat thick enough to cover wire and make smooth surface. A bag weighing 100 pounds will cover about 40 square feet. JAMES A. PRATT.

Howard, R. I.

PRICK-PUNCH WITH INTERCHANGEABLE SCRIBER POINTS.

In the tool shown herewith, we have a departure from the simple construction of the ordinary prick-punch inasmuch as it is made so that a number of interchangeable points can be substituted at will. While such a tool is one that will be appreciated by the traveling mechanic as it helps him in keeping the weight of his kit within portable limits, its principal advantage lies in that the point can be kept sharp easier since



the cross-section does not increase much up to the holder. When the point is ground away, another can be substituted without bothering the tool-dresser. Moreover, it is something different from the ordinary tool, and that is a distinction that many men like. C. C. ARRAS.

Buffalo, N. Y.

HACK SAW KINKS.

We all know how difficult it is at times to saw straight in the regular run of power hack saws, but to overcome the difficulty is a very simple matter if we only knew how, and here's the how. For instance, we have a piece of mild steel, say ¾-inch thick by 3 inches wide to saw. We know it "goes" much quicker to saw it edgewise than flat, so we want to keep on doing so, but first of all start the cut on the flat side and let the saw make a few strokes, enough to go into the metal about ⅛ inch, then set up on edge so the saw is directly over the cut first made and, following along the lines that "water won't run up hill," but will follow the path of least resistance, same as lightning, steam, electricity, etc., the saw will be guided by the shallow saw cut. Another point to be observed in the use of hack saws for either power or hand frames is preventing further damage to the saw when a few teeth are broken out. Stop right there and grind the teeth on each side of the break on a gradual slant in toward the opening. This will make the saw almost as good as before and prevent ripping out more teeth. R. A. LACHMANN.

Chicago, Ill.

A PIPE FISHING JOB.

I was once called upon to devise a scheme by which a piece of 1½-inch pipe about 15 feet long, which had accidentally fallen to the bottom of an artesian well, could be abstracted. The well mentioned was of 3-inch pipe and 85 feet in depth, the last ten feet being driven in quicksand, which had sifted in through the strainer in considerable amount. This, in conjunction with the additional piece of pipe which had forced its way into it several feet, was checking the supply of water, and as the boiler depended entirely upon the water supply from this well (there being no running water in the village), matters became serious. After considerable meditation the following method was decided upon:

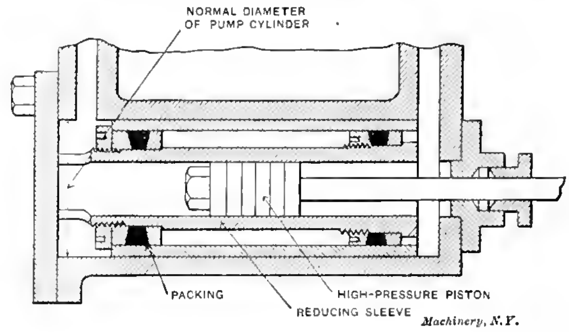
Four lengths of ½-inch gas pipe, a 1½-inch to ½-inch reducing coupling, and a piece of thoroughly seasoned pine were procured, the latter being turned into a long, slightly tapering plug to fit the 1½-inch pipe. One end was securely fastened to the reducer coupling, and the other end was sharpened to a point. As soon as one length of pipe had been lowered into the well another was screwed on as quickly as possible, and when at last the desired goal was reached the plug was crowded firmly into the pipe and given time to swell. It was necessary to use considerable force to start the pipe out of the sand but it stood the test without the slightest slip.

New Haven, Conn. OTIS D. STORER.

* * *

REDUCING SLEEVE FOR PUMP CYLINDERS.

A simple method by which an ordinary boiler feed pump may be converted into a high-pressure pump for testing purposes is shown in the illustration. It consists of a reducing sleeve which is inserted into the pump cylinder and which is provided with suitable stuffing-boxes to prevent the water bypassing from one end of the cylinder to the other. The regular



pump piston is removed, of course, and a smaller one substituted of the proper size to fit the reducing sleeve. The scheme is one that has met with some favor in marine service, as it enables an engineer to test any of his boilers with one of the regular feed pumps and it saves the labor necessary to work hand test pumps.

* * *

The effect of the traction wheels of electric motor cars seems to be quite different than from that of the drivers of locomotives. This was alluded to by Mr. H. M. Steward in a paper read before the New England Street Railway Club, October 27, 1904. An engine driver can be spinned or turned in the same place for some time without injuring the rail, the only result being that the rail becomes slightly burned and hardened at the point where the driver was turning. But in the experience of the Boston Elevated Railway, if the motor wheels of the car are kept turning for any length of time they will actually cut a 85-pound rail in two. There have been cases where trains have been stalled on grades, and in endeavoring to start the train, the motor wheels have been revolved in the same place for a short time with a result that deep holes had been cut into the rails. When this has occurred the trains could not have started by their own power, but were obliged to remain where they were until pulled or pushed out of the holes.

SHOP RECEIPTS AND FORMULAS.

Practical Tried Receipts—those known to be Good—are Solicited.

SOMETHING ABOUT THIS DEPARTMENT.

The object of this department is to publish practical tried shop receipts that are known by the contributor to be O. K. It is one thing to make a collection of receipts and formulas, and quite another thing to be sure that each one is good. With the coöperation of our readers we hope to put on record during the next year or two the best collection that has ever been published, inasmuch as each is expected to have the personal recommendation of its contributor. Remember that we pay for all accepted contributions, and that we pay more for receipts than for any other class. Requests for specific receipts that are not generally known will appear in the "How and Why" department.—EDITOR.

CEMENT FOR IRON.

Six parts of white lead, 6 of sulphur and 1 of borax, thoroughly mixed and wetted with strong sulphuric acid makes a very strong cement. DAVID MELVILLE.

Detroit, Mich.

MIXTURE FOR FIRE CEMENT.

To make a fire cement use 100 parts fire clay, wet; 3 parts black oxide manganese; 3 parts white sand; and ½ part powdered asbestos. Thoroughly mix, adding sufficient water to make a smooth mortar. C. E. MINK.

Syracuse, N. Y.

TO COPPER BRASS FOR LAYING OUT WORK.

To apply a copper coloring upon brass for laying out work, put a few drops of the ordinary coppering solution upon the brass and then dip a piece of iron or steel into the solution and touch the brass. OSCAR J. BEALE.

Providence, R. I.

TO PREVENT BABBITT METAL OR LEAD FROM EXPLODING.

Before pouring the babbitt metal, throw in a piece of resin the size of a walnut and allow it to melt. If the bearings to be lined with babbitt are warmed before pouring, the metal will run better, thus insuring a better job.

Schenectady, N. Y. R. B. CASEY.

VARNISH FOR STEEL.

A good varnish for steel may be made by dissolving 10 parts of clear grains of mastic, 5 parts of camphor, 15 parts of sandarach, and 5 parts of elemi in a sufficient quantity of grain alcohol. Apply the varnish without heat. JOS. M. STABEL.

Rochester, N. Y.

TO SOFTEN HARD CAST IRON FOR DRILLING.

Heat to a cherry red, having it to lie level in the fire. Then with a pair of cold tongs put on a piece of sulphur a little less than the size hole to be drilled. This will soften the iron entirely through, providing it is not too thick.

Dayton, O. O. E. VORIS.

TO REMOVE BLUING FROM TEMPERED STEEL.

Plunge the blue hot article into a bath of sulphuric acid 1 part, water 16 parts; then into a bath of lime and water (to neutralize the acid) and rub it off quickly with a dry cloth and Vienna lime. The result will be a most beautiful polish.

Angelica, N. Y. F. H. JACKSON.

POLISH FOR BRASS. POLISH FOR STEEL.

A good polish for brass is made by putting 2 ounces of sulphate of nickel and 2 ounces of nitric acid in an open vessel and allowing them to mix thoroughly. Then add water.

To make a polish for steel dissolve 2 ounces each of oxalic acid, pumice stone, ammonia, and whiting in a quart of water.

New York. HERMAN JONSON.

CEMENT FOR HOLES AND CRACKS IN CASTING.

A cement for holes and cracks in castings is made of 6 parts red lead, ground in oil; 3 parts white lead, ground in oil; 2 parts black oxide of manganese; 1 part silicate of soda; ½ part litharge. Mix and use as a putty. To preserve from hardening put in a vessel and cover with water.

Syracuse, N. Y. C. E. MINK.

ETCHING FLUID.

Mix 1 ounce of sulphate of copper, ½ ounce of alum and ½ teaspoonful of salt reduced to a powder with 1 gallon of vinegar and 20 drops of nitric acid. This fluid may be used for eating deeply into the steel or metal, or for imparting a beautiful frosted appearance to the surface according to the time it is allowed to act. DAVID MELVILLE.

Detroit, Mich.

LUBRICANT FOR DRAWING DIES.

The following mixture has given very good results as a lubricant on drawing dies when drawing sheet metal. Boil together until thoroughly mixed, 1 pound of white lead, 1 quart of fish oil, 1 pint of water, and 3 ounces of black lead. Apply to the sheet metal with a brush before it enters the dies.

Rochester, N. Y. JOS. M. STABEL.

THE USE OF BRASS WIRE IN BRAZING.

In place of spelter use wire or rod brass and boracic acid as a flux. Anneal the end of wire or rod by heating while the joint is getting hot, and after dipping the rod into boracic acid, apply to the joint; the rod melting at the end will flow into the joint. After the joint is cooled, submerge in hot soda water; this will take off every particle of acid, leaving only the brass to be filed off. F. H. JACKSON.

Angelica, N. Y.

FOR BLUING SMALL BRASS AND STEEL ARTICLES BY IMMMERSION.

To blue small brass articles by immersion, use chloride of antimony, 1 ounce; water, 20 ounces; hydrochloric acid, 3 ounces. Place the solution in an earthen jar and suspend the piece in this bath until blue, then wash and dry in sawdust. The pieces should be warmed first.

To blue steel without heat, apply nitric acid; wipe off the acid clean, oil and burnish. L. E. MUNCY.

Syracuse, N. Y.

TRANSMISSION ROPE DRESSING.

A good transmission rope dressing is made by melting together 150 pounds of tallow, 33 pounds resin, 150 pounds beeswax, 20 pounds pine tar, 11 pounds lampblack, and 15 pounds tobacco tin-foil. Pour the mixture in molds to make stock 2½ inches in diameter, and 11 inches long, weighing about 3 pounds each. Use one for about 100 feet of one-inch rope.

New York. HERMAN JONSON.

VARNISH FOR CAST IRON PATTERNS.

For small cast iron patterns the following is a very satisfactory method of varnishing. Apply boiled linseed oil to the iron, the pattern being heated to a temperature that will just char or blacken the oil; the oil appears to enter the pores of the iron, and after such an application the metal resists rust and corrosive agents very satisfactorily. JAMES A. PRATT.

Howard, R. I.

CASE-HARDENING CAST-IRON.

To successfully caseharden cast iron the pieces to be hardened should be heated to a red heat, then rolled in a composition of equal parts of prussiate of potash, salammoniac and saltpeter. All pulverized and thoroughly mixed. Every part of the casting must be covered by the composition before plunging (red hot) into a bath of 2 ounces prussiate of potash and 4 ounces salammoniac to each gallon of cold water. A.

TO BRONZE YELLOW BRASS.

To produce a bronze finish on rough yellow brass castings, mix equal parts of nitric acid, sulphuric acid and water; the nitric acid and water should be mixed first and the sulphuric acid added slowly. Dip the yellow brass castings into boiling water a moment, then in the acid solution, then quickly back into the boiling water, and rinse thoroughly in clean water. Dry in pine sawdust. The castings must be perfectly free from soldering solutions, etc., or stains are liable to appear. This method gives a finish similar to gas fixtures, etc., and may be rendered very permanent by coating with a transparent lacquer. I. W. ANTANO.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

The following questions are referred to our readers:

50. A. R. T.—How are hacksaw blades hardened so that the teeth are hard and the backs left soft?

51. I. T. O.—I want a good process for tinning wire goods like the wire baskets for office desk use; the use of pure tin has been unsatisfactory with me because of the expense of pure tin, which costs about 33 cents a pound. Perhaps if I could get a thin even coating all over the goods it would be cheap enough, but this I have been unable to secure so far. Can a mixture of tin and lead be used for this purpose successfully?

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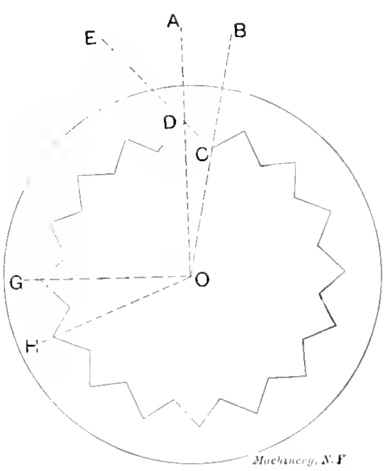
52. L. E. M.—Please give me a rule for figuring the angle to make a V tool to plane notches in the inside of a hole or ring, and leave points of a given angle. I would like a rule that will cover this, irrespective of number of divisions or diameter of circle.

A.—The sketch represents a ring, on the inside of which teeth have been cut as shown. Since the tool is to be shaped to cut out the notches between the teeth, the angle of the tool must be equal to the angle between the sides of any one of the notches. Draw the radial line OA, bisecting one of the notches, and the radial line OB bisecting one of the teeth.



Then $ECB = \frac{1}{2}$ angle of tooth, $ODC = \frac{1}{2}$ angle of tool, and $AOB = \frac{1}{2}$ center angle. By center angle is meant the angle between radial lines drawn from the center of the ring to corresponding points of two adjacent teeth, as for example, angle GOH. By a principle of geometry, the exterior angle ECB of the triangle ODC equals the two opposite interior angles of the triangle.

Hence, angle ECB = angle ODC + DOC, or

angle ODC = angle ECB — angle DOC.

Multiplying by 2,

2 × angle ODC = 2 × (angle ECB — angle DOC), or

Angle of tool = angle of tooth — center angle

$$= \text{angle of tooth} - \frac{360}{\text{number of teeth.}}$$

Example: Required, angle of tool when angle of tooth = 90 degrees and the circle is to be cut with 60 teeth.

$$\text{Angle of tool} = 90 - \frac{360}{60} = 90 - 6 = 84 \text{ degrees.}$$

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53. E. J. B.—Is there any way in which a wattmeter can be made to creep or not creep, at the will of an operator at a central station, and when all the switches at the receiving station are cut out, and no motors running. I have one in my charge that has been creeping every night and Sundays for six weeks, yet when under investigation by myself and officials of the power company it does not creep at all, and under exactly the same conditions.

Answered by Mr. Wm. Baxter, Jr.

Any one who is thoroughly familiar with the wiring from the generators or switchboard to the receiving station, can make connections through which the wattmeter can be made to creep. The two sketches, Figs. 1 and 2, show how it can be done, the first arrangement being that required if the consumer is connected with the line through a single pole switch, and the second if the connection is through a double pole switch. The vertical line $a\ a$ separates the station end from the consumer end, the latter being on the right side of the line. In Fig. 1 if the consumer's circuit is grounded as at g' and the station is grounded at g, with a switch to make and break the ground connection, then when this switch is closed, the circuit will be completed, and if there is a path in the con-

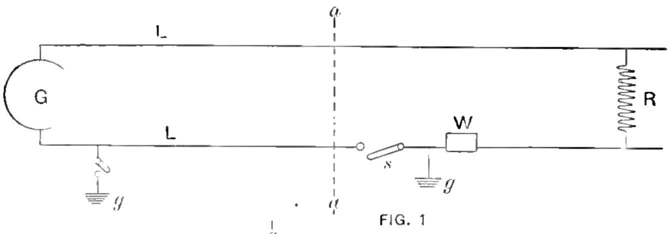

FIG. 1

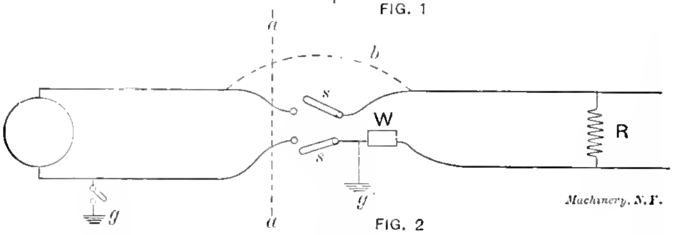

FIG. 2

sumer's circuit as indicated by R, current will pass in an amount that will depend upon the resistance at R. It is not customary to use a single pole switch to connect a consumer with the lines, therefore, the case shown in Fig. 2 is more likely to be met. In this case the arrangement is the same as in the first sketch with the exception that a connection is made around the upper switch s by means of the wire b. Any such condition as is above indicated, can be detected by disconnecting your circuit from the line completely and then testing it for grounds and for connection with the station circuits.

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54. A. H. N.—What is the best practice for relieving the teeth of hand taps? Some toolmakers, I find, are firm believers in relieving the teeth; others claim that it is not only unnecessary, but harmful.

A.—Practice differs quite widely; some manufacturers, we believe, still adhere to the older system of relieving the teeth by backing off, *i. e.*, making the tooth narrower and the thread channels deeper at the heel than at the cutting edge; others have abandoned this method and now make hand taps which work very successfully without having any relief whatever, in the ordinary meaning of the term. The newer practice is to cut the thread slightly deeper at the shank end of the thread than at the point, or, in the case of a taper tap, where the thread reaches full diameter. The taper at the root of the thread is usually about 0.001 inch per inch of length, but, in no case, should it be more than 0.003 or 0.004 inch in the length of tap. Thus, a one-inch plug end tap having three inches of thread would be about 0.003 inch less diameter, measured at the shank than at the point. With a taper tap having one-inch taper and two inches of full thread, the shank end would measure about 0.002 inch less at the root of the thread than at the full diameter. This practice is very simple and is claimed to give uniformly excellent results. It works particularly well on taps that have to be backed out, as it removes the liability of chips wedging in on the back of the teeth and breaking them, which is a fault with the back-off teeth. The foregoing does not apply to pipe, boiler, machine and staybolt taps, as these should be relieved in the angle of the thread as well as at the top.

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55. A. L. B.—I recently made a sketch for laying out a right angle channel on the end of a steel block, 9 inches square, so that when planed out the cross-section shape would be like that shown in the cut herewith. One side of the block was to be 8 inches and the other 9 inches high after planing, and the thickness of metal at the bottom of the channel was to be 5 inches. The two flats Aa and Cc, were to be of the same width, and the sides of the channel, AB and BC, of the same length. Although this was all the data given it was a simple matter to make the sketch to fill the bill, but when I tried to calculate

the distances AB and y, to verify the layout dimensions, I got stuck. Is there a simple way of finding these distances by calculation, with the given data?

A. One solution, which can scarcely be called simple, is as follows: Add to the diagram, Fig. 1, the lines AD, DB, BE and EC, drawn parallel to the sides of the block; also the lines AF and AC as shown in Fig. 2. Then by subtracting the 5-inch dimension, representing the distance from the bottom of the channel to the base, from the respective sides, it is found that EC is 4 inches, and AD 3 inches. We also discover

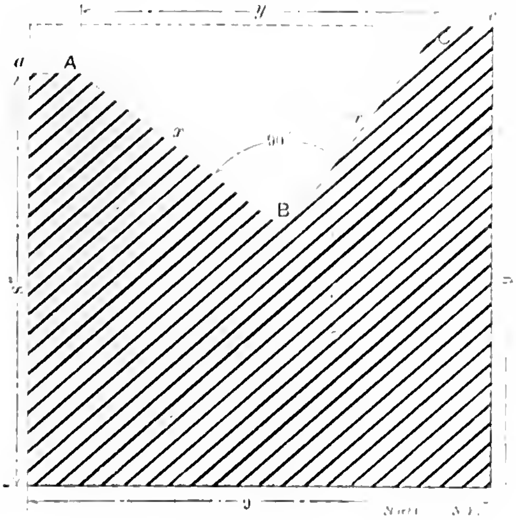

Fig. 1.

that AF is 1 inch, since the short side after planing measures 8 inches and the original height was 9 inches. Triangles AFC, ADB, BEC and ABC are right angled, hence the sums of the squares of the sides of each equal the squares of their respective hypotenuses. Therefore,

$$AB^2 = BD^2 + 3^2 \text{ and}$$

$$BC^2 = BE^2 + 4^2$$

$$AB^2 - 9 = BD^2$$

$$BC^2 - 16 = BE^2$$

$$\sqrt{AB^2 - 9} = BD$$

$$\sqrt{BC^2 - 16} = BE$$

Since $AB = BC$, and $DB + BE = FC$, it follows that

$$\sqrt{AB^2 - 9} + \sqrt{AB^2 - 16} = FC$$

$$AB^2 - 9 + 2\left(\sqrt{AB^2 - 9}\,\sqrt{AB^2 - 16}\right) + AB^2 - 16 = FC^2$$

In the triangle ABC

$$AB^2 + BC^2 = AC^2 \text{ but}$$

$$AC^2 = FC^2 + AF^2 \text{ hence}$$

$$2AB^2 = FC^2 + 1$$

$$2AB^2 - 1 = FC^2 \text{ therefore,}$$

$$2AB^2 - 1 = AB^2 - 9 + 2\left(\sqrt{AB^2 - 9}\,\sqrt{AB^2 - 16}\right) + AB^2 - 16$$

$$2AB^2 - 1 = 2AB^2 - 25 + 2\left(\sqrt{AB^2 - 9}\,\sqrt{AB^2 - 16}\right)$$

$$2\left(\sqrt{AB^2 - 9}\,\sqrt{AB^2 - 16}\right) = 24$$

$$AB^4 - 25AB^2 = 0$$

$$AB^4 - 25AB^2 + 156\tfrac{1}{4} = 156\tfrac{1}{4}$$

$$AB^2 - 12\tfrac{1}{2} = 12\tfrac{1}{2}$$

$$AB^2 = 25$$

$AB = 5$, from which it follows that

$DB = 4$ and

$BE = 3$, hence

$FC = 7$

The width of the flats Aa and Cc is 1 inch.

56. L. H. W.—In using the rule given in Mr. Woodbury's article in the December, 1904, number of MACHINERY upon the location of the decimal point in slide rule calculations, I find it true with the lower scales. How can it be used with the upper scales?

Answered by Mr. S. E. Woodbury

In the body of the article a sentence reads: "This method is best used with the C and D scales, but can be used as well with the A and B scales after it is once understood." The application is a little indirect, but possibly an example will make it clear. Multiply 3.5 by 3.1416 on the C and D scales; the result is 11. The slide projects to the left and covers the sign P +, therefore there are 1 + 1 = 2 digits in the result. Using the A and B scales set the left index of B to 3.5 in the left of A, and the result 11 is read in the right of A over π on B, that is, the result is read in the other half of the scale from that in which one of the factors was taken. This corresponds to the slide projecting to the left when using the C and D scales, hence there is no correction, and there are 1 + 1 = 2 digits as before. Without disturbing the slide as set for the last reading, it will be noted that under 3.5 in the right half of the A scale is found the middle index of the B scale, and the result is over π as before. The relation of these scales is identical to that of the C and D scales for the same result. Reversing the example and attempting to divide 11 by 3.1416 we find a similar relation of the scales for division. From these relations we can form the rule for the correction. When the result of multiplication or division is found in the same half of the A scale as that from which a factor or a dividend is taken, there is a correction of − 1 or + 1 respectively. When the result is found in the other half of the A scale from that in which a factor or a dividend is taken there is no correction. This assumes that only one (though it may be either) half of the B scale is used in any calculation.

The following method of locating the decimal point in calculations performed on the A and B scales may be of interest. Near the 3.5 mark in the left half of the A scale write the

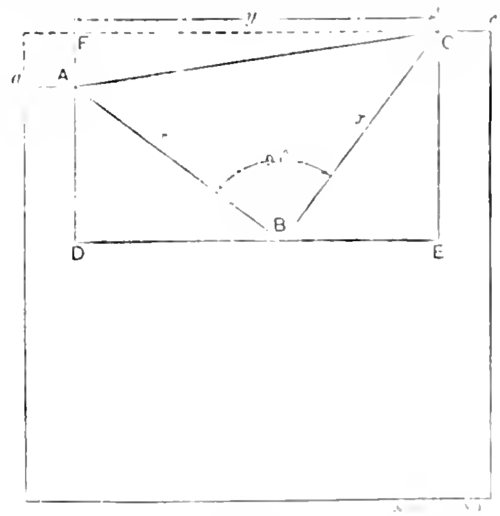

Fig. 2.

sign P—, and near the 3.5 mark in the right half of the A scale write the sign Q +. Always take one factor for multiplication in that portion of the scale where the P − is, and always take the dividend in that portion of the scale where Q + is. Use only one half of the B scale, reading at the middle index when necessary. If a result of multiplication occurs in the portion of the scale under P −, 1 is to be subtracted from the sum of the digits; if the result occurs in the portion of the scale where the Q + is, there is no correction since Q + does not refer to multiplication. If a result of division occurs in a portion of the scale where Q + is, 1 is to be added; if the result occurs in the portion of the scale where P — is there is no correction, since P − does not refer to division. I prefer this to any other direct method as applied to the A and B scales, but consider the slightly modified form of the rule for the C and D scales more satisfactory.

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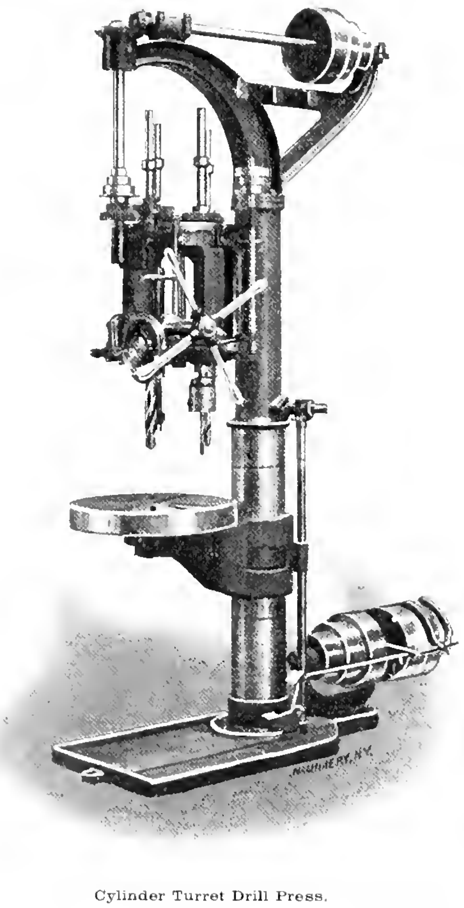
It is suggested that one reason for the extreme secrecy under which certain electric furnace processes are carried out is their simplicity. The extension of ordinary courtesy to visiting engineers in many electrochemical plants would reveal the processes to such an extent that the visitor could carry away the entire scheme in his head and become a competitor in short time.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

CYLINDER TURRET DRILL PRESS.

A cylinder turret drill press brought out by the National Separator & Machine Co., Concord, N. H., is illustrated herewith. This machine is for drilling, tapping, reaming, etc., on duplicate parts without the necessity of changing the tool or the work. It can be furnished with four spindles as shown in the illustration or with six, and with either power, hand or lever feeds or all of these. The turret carrying the spindles revolves in the outer casing, and is arranged so that when the desired spindle is turned to the front the driving gear connects with the gear on the spindle and causes it to revolve, while the other spindles are left back out of the way and inactive. When the other spindles are to be used the turret is revolved to each in turn. As shown in the cut the same size gear is placed on all the spindles but one, which is geared down for tapping and counterboring. The spindles can be fed to the work directly by the star wheel, by the hand wheel in front, or by power, and can be set to stops to knock off automatically. There is an independent stop for each spindle. All the spindles work to the same point on the platen. A locking device is provided directly in front of the spindle, the turret locking automatically when in position. There is little strain on the turret, as the moment power is applied the strain passes to the frame, the turret acting simply as a guide. The number 1 size of this drill will carry up to 1-inch drills, will swing over the platen 24 inches, and carries four spindles, one being a slow-speed spindle. It is provided with power and lever feed and stops for each spindle.


Cylinder Turret Drill Press.

THE DRAPER GEARED HEAD LATHE.

The Draper 18-inch patent geared lathe is shown in the accompanying half-tone, Fig. 1. An interior view of the head with the cover removed is shown in Fig. 2. The lathe is driven by a wide-faced pulley with a six-inch belt, giving 10 geared speeds to the spindle, obtained by sliding gears operated by levers, as shown in the half-tones. The lathe is made to withstand severe duty, having power either for heavy reduction or fast cutting speed for finishing cuts. The driving shaft is at the back of the lathe, or the top of the interior view, Fig. 2. On this are mounted two sliding gears *G* and *A* operated by the middle lever at the front of the head. These gears mesh in either one of the two gears *H* and *B*, shown on the sleeve running loose on the main spindle. The front countershaft with its four gears, *D*, *K*, *L* and *E*, is operated as is the usual back gear shaft. By throwing out these gears with the eccentric through the handle to the left, Fig. 2, and locking the spindle train with the knob shown protruding from the face of gear *M*, Fig. 2, two rates of speed may be obtained through *A* and *B*, or *G* and *H*. This knob is made accessible to the operator by means of a small plate on top of the cover. With the spindle gears disconnected and the back gear shaft thrown in, there are eight more speeds, making ten in all with the single speed countershaft or the constant speed motor. These eight back geared speeds are obtained by the meshing of either *A* with *B* or *G* with *H*, *C* with *D* or *I* with *K*, and *E* with *F* or *L* with *M*.

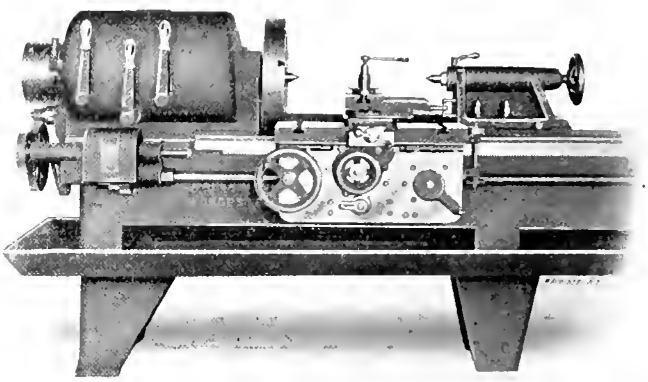


Fig. 1 Draper Geared Head Lathe.

The belt-driven lathe is usually furnished with a two-speed countershaft which, in this case, gives twenty forward speeds to the spindle. A backing belt is not required, as a thread indicator is attached to the right-hand side of the carriage, as shown in Fig. 1, so that odd, even or fractional threads can be caught with the half nut after returning the carriage by hand when chasing threads. The head is rigid, and is so constructed as to form a reservoir, which permits the gear train to run in oil. The lathe is easily changed from belt to motor drive; a cover with brackets for the mounting of the motor is substituted for the plain cover of the head, and a train of gears or chain drives from the armature shaft to the driving shaft mounted at the back of the lathe.

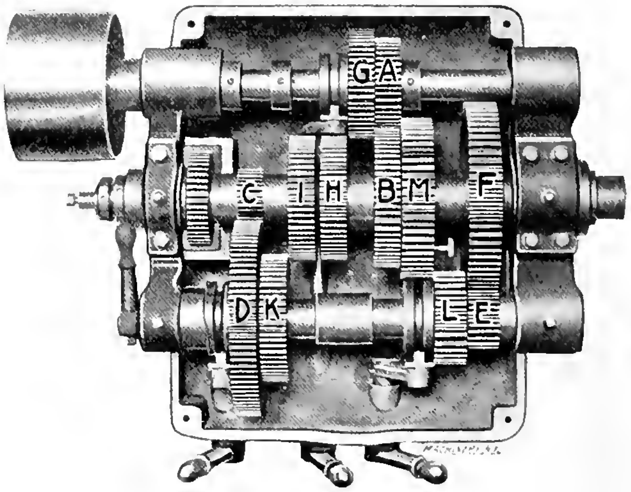


Fig. 2. Interior of Head with Cover Removed.

The tailstock is extra long, is well braced, has set-over screws, a large diameter spindle and is clamped to the bed by four bolts. The forward pair of these bolts are as close to the end of the tail as possible, to counteract the lifting strain of the

cut. The carriage is heavy, has a wide bridge and long bearings, and is usually furnished with a compound rest having a long movement to the top slide. The apron is of box form, and gives all shafts having severe duty bearings on each end. The inner bearing of the rack pinion is bolted to the carriage at the point where it engages in the rack.

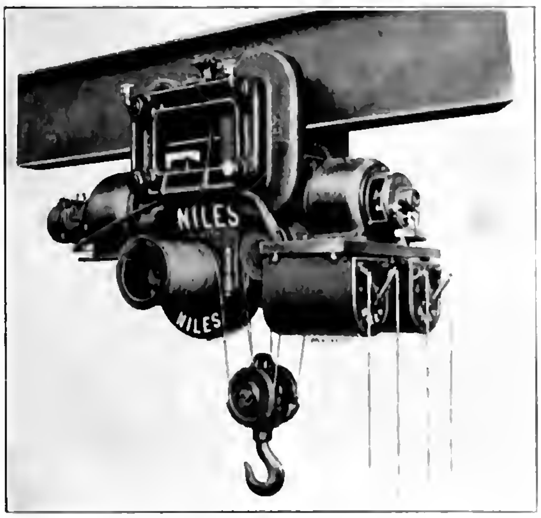
The lathe, as illustrated, gives three changes of feed or screw pitches without change of gears. It can, however, be made with quick change feed device in the apron, giving 40 changes of speed or screw pitches without change of gear. The feed mechanism is so constructed that the operation of any feed locks out all the others. The feed is from a splined leadscrew, the threads of the screw only being used for screw cutting. The cross and the lateral feeds are engaged by the same friction; pulling forward the friction handwheel engages the lateral feed, while the reverse movement engages the cross feed.

This lathe is also made with a double independent tool block with set-over to front tool block for splitting the cut. The patent geared head is furnished in all sizes from 18-inch to 42-inch swing inclusive. These lathes are made by the Draper Machine Tool Co., Worcester, Mass.

NEW NILES ELECTRIC TRAVELING HOIST.

An electric traveling hoist, built by the crane department of the Niles-Bement-Pond Company, is shown in the accompanying illustration. The hoist is compact and self-contained in one heavy cast-iron frame, to which the motors are attached, end on.

The power is transmitted directly from the armature shaft to the drum shaft through one train of worm and worm-wheel



Electric Traveling Hoist

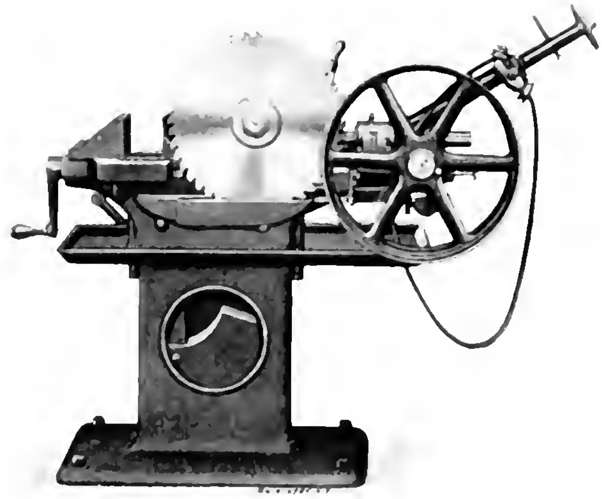
gears. The traversing mechanism is also driven through one train of worm and worm-wheel gears, similar to the hoisting mechanism, except that, when the trolley is arranged to run on a single I-beam, a double set of transmission gears is used. All the mechanism is enclosed in oil and dust-proof casings, and is absolutely noiseless in operation. In addition to the braking effect obtained by the use of the worm and worm wheel, a powerful electric brake is attached to the hoist motor.

These hoists when mounted on a traveling bridge may be used as small capacity cranes. When used as cranes, the hoists are arranged to run between the two I-beams or channels of the bridge, and the controllers for raising and lowering the hook and operating the traversing mechanism may be placed either on the hoist, on the bridge, and operated by cords from the floor, or in an operator's cage attached to the bridge.

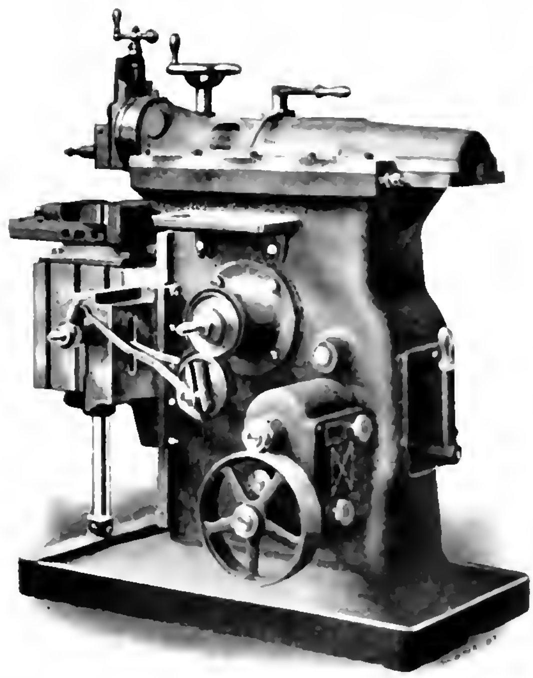
The Niles hoists are built in capacities of three-fourths to six tons, and are usually arranged to run on an I-beam track. They will run on straight and curved tracks, and are generally provided with a separate motor for traversing, but if desired, hand traverse may be furnished, or all the traversing mechanism may be omitted and the trolley moved along the track by pushing on the load. The increased service of the electric traverse, however, much more than compensates for the slight additional cost

AUTOMATIC COLD SAW CUTTING-OFF MACHINE

The Hill Standard Mfg. Co., Anderson, Ind., have recently put on the market an automatic cold saw cutting-off machine which we show in the accompanying illustration. With this machine the saw blade is not revolving when work is being put into and removed from the vise; hence there is no danger of the workmen being caught. The revolution of the saw is


Automatic Cutting-off Machine

started by the advance of the saw blade toward the stock, this action throwing in the clutch. The position of the saw mandrel is so related to that of the axis of the work in the vise that when the stock is almost cut off and begins to weaken the saw cut is opened by gravity, thus preventing any pinching of the blade. The feed is automatically released when the work is cut off, the saw returning to the starting position


Crank Shaper with Gear Box

and its revolution ceasing at the same time. An automatic saw sharpening attachment by which the saw may be sharpened on the mandrel goes with the machine, thus avoiding the troubles which arise when the saw blade has to be removed to another machine for sharpening and then replaced on the sawing machine. The saw of this cutting-off machine is 11 inches diameter by 5/32 inch thick, and it has a capacity of 3 x 4 inches.

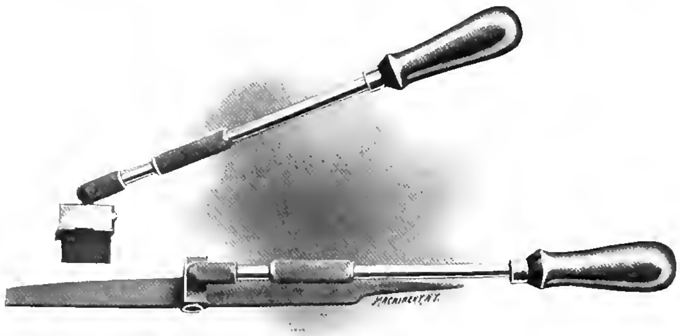
CRANK SHAPER WITH GEAR BOX

Herewith is illustrated a 16-inch back geared crank shaper with gear box attached. The shaper is one of the standard machines of the Cincinnati Shaper Co., Cincinnati, O., with the cone pulley left off and the gear box attached in its place.

There are three shafts in the box, two of which carry sliding gears; these are moved and locked by the hand nuts shown. This gear box can be applied to any of the company's back geared crank shapers at any time and provides all changes of speed obtainable through the usual cones, and gives further the advantage of a large area of belt contact at all speeds without shifting the belt.

LUTZ UNIVERSAL TOOL HOLDER.

A file holder is shown below by which files and short pieces of files may be conveniently handled for filing grooves, sharp corners and other irregularities where the handling of an ordinary file would be awkward. The holder consists of a vise head containing two movable jaws which hold securely any short piece or whole file. The handle bar is joined to the vise head by a universal ball joint. The vise head can be adjusted

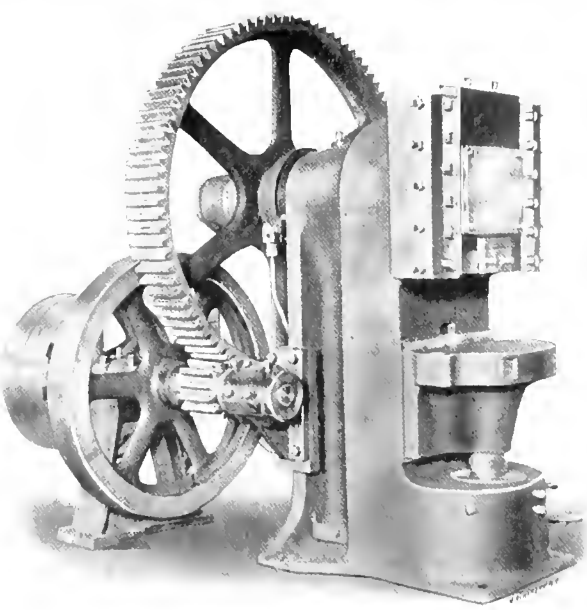


Universal File Holder.

and tightened in any desired position by unscrewing and screwing the handle bar; the latter being provided with a knurled grip. The various working parts of the holder are made of case-hardened steel. The holder may be used for holding regular files for flat and grooved surfaces, round or square short piece files for concave work or square corners, or short piece files either flat or edgewise. The holder is made by the Lutz Tool Mfg. Co., Springfield, O.

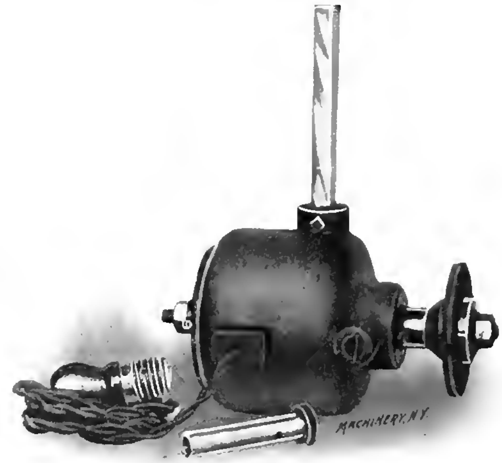
PRESS FOR HEAVY PUNCHING.

A new type of power press adapted for heavy punching, stamping, etc., in the manufacture of fittings for electrical motors and dynamos and other work requiring heavy pressure,



Power Punching Press.

has been built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., and is shown in the accompanying half-tone. The frame of the press is a solid casting and weighs about 15,000 pounds. The shaft is of large diameter, has a $1\frac{3}{4}$ inch stroke and is directly connected to the slide without any adjustment, the latter being obtained by raising or lowering the bed, which is supported on a screw of large diameter in addition to being bolted and gibbed to the frame. The screw gives an adjustment of one inch to the table, and is securely locked by a threaded key with two setscrews. The press is controlled by an automatic jaw clutch which positively locks the large gear

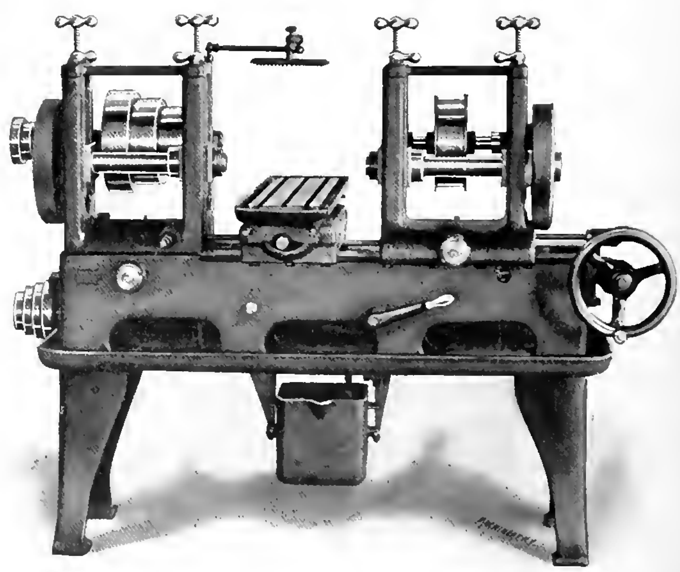


Electrical Lathe Center Grinder.

to the shaft and releases same after the press has made one revolution. There is an extra long slide, and gibs are provided which guide the punches held in them. The bed of the press is 17 x 20 inches, the distance between the gibs is 16 inches and the depth of throat is six inches.

ELECTRICAL LATHE CENTER GRINDER.

Mr. J. F. Willey, Louisville, Ky., is making a new electrical lathe center grinder which is sold by James Clark, Jr., & Co., also of Louisville. In this tool, shown below, the usual slide for feeding the wheel has been eliminated, the feed being attended to by the lathe compound rest upon which the grinder is placed. The compound rest of course can be quickly set to



Double Head Milling Machine.

the desired angle of the center to be ground. When used on lathes equipped only with plain rests, separate cuts are taken equal to the width of the wheel. The bearings of the grinder are conical and adjustable for wear. By leaving out the separate slide feed a more solid construction at less cost is claimed. A high speed is said to be obtained through an improved method of winding.

DOUBLE HEAD LINCOLN MILLING MACHINE.

The Niles-Bement-Pond Co., of New York, have recently brought out a double head milling machine which is shown in the accompanying illustration. This machine is adapted for a similar class of work to that of the single head Lincoln milling machine, but on the double head machine two milling cutters of different diameters may be used, the drive for each

head being independent. On some classes of work this results in a great saving of time over the use of the single head machine. The head shown to the left is fixed and has nine spindle speeds, being driven in connection with a clamp cone pulley of three steps. The movable head to the right is driven through a flanged pulley and has three spindle speeds. For very heavy work both heads may be used to drive the same arbor. The dimensions of the table are 32 inches by 7½ inches, and it has a travel of 15 inches. The table is adjustable laterally 6½ inches, and the spindles may be adjusted vertically 8¼ inches. Four changes of feed are provided.

RAPID REDUCTION LATHE, NINETEEN-INCH CAPACITY.

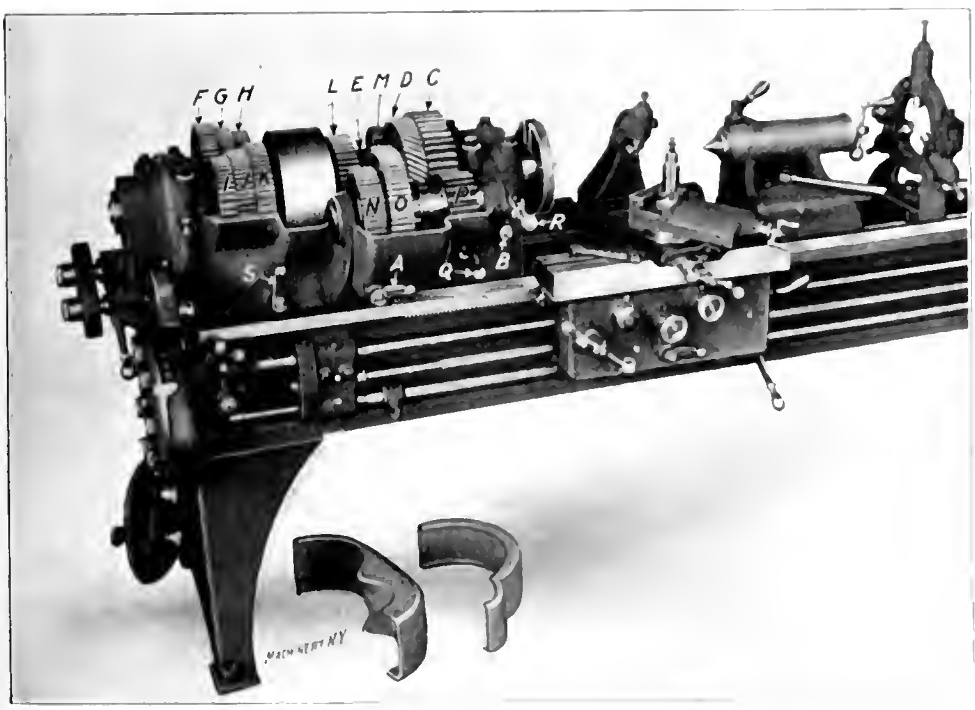
Herewith is illustrated a lathe recently designed by the Springfield Machine Tool Co., Springfield, O., having a capacity sufficient to swing a piece 19 inches in diameter in the rough.

Tho point of greatest interest in this design is the headstock. Twenty spindle speeds are obtainable hereby with a two-speed countershaft; the drive being from a 12-inch single face pulley running direct upon the spindle at moderate speed. A 4½ inch belt is used. These 20 speeds are, first, two direct belt speeds obtainable by a positive clutch operated by handle *A* connecting the driving pulley to the spindle. Secondly, six speeds are obtained when lever *A* is in the position shown and face gear *C* is connected to the spiral gear *D* by a positive clutch operated by lever *B*. The spiral gear *D* is driven by its pinion keyed to the shaft *E* in the rear, this shaft having three gears, *F*, *G* and *H*, mounted loosely upon it and meshing with gears *I*, *J* and *K*, which are keyed fast to the pulley. Any one of the gears *F*, *G* and *H* may be connected to its shaft *E* by an interior positive clutch operated by handle *S*.

Twelve more spindle speeds are obtainable through the double back gears which are placed in front of the spindle. Face gear *C* is disconnected from the spiral gear *D*, allowing the latter to revolve freely upon its spindle. Keyed to spiral gear *D* are two gears, *L* and *M*, either of which may engage back gears *N* and *O*. The drive is then from the pulley through gears *I*, *J* or *K* with *F*, *G* or *H*, through *E* and *D*; and either *L* or *M* with *N* or *O*, and lastly through pinion *P* and face gear *C*. Gears *N* and *O* are positively locked in one or the other driving position by a hook upon lever *Q*, which also affords means for sliding the gears from one position to the other. This lever receives its locking and unlocking motion from handle *R*, which has an eccentric projection extending through the housing in which the back geared shaft is mounted, with an eccentric bush at the other end. By this system eight finishing speeds are provided, namely, two direct belt speeds and six through the spiral gearing, which latter produces a smooth motion. The twelve back geared speeds remaining are for roughing and heavy cuts upon large diameters. The speeds are arranged to give a constant cutting speed for diameters from 1½ to 18 inches. The back gearing is disposed as it is in front of the spindle to relieve the caps of strain

Nutting Arbor Press

The carriage has one V and one flat bearing. It has a power cross movement, the cross feed screw having a micrometer collar reading to 1/1,000 of an inch. A clamp is provided for the carriage when facing. The tailstock is heavy, with a large spindle fitted with a number 5 Morse taper center. The spindle is clamped by two bushes, insuring proper alignment of the spindle. The headstock spindle has a 1 9/16 inch hole its entire length and runs in self oiling bearings. The center corresponds to a No. 5 Morse taper. The apron is double, furnishing two bearings for all studs. The rack pinion has a bearing supporting it close to the rack and may be withdrawn when screw cutting.



Springfield Nineteen-inch Lathe

The lathe, as illustrated in the cut, is equipped with the rapid change gear mechanism furnished by the makers with their Ideal lathes. This machine may however, be equipped with a positive geared feed, giving six variations of feed, and regular change gears. The countershaft has one tight pulley and two friction pulleys of an improved form.

NUTTING ARBOR PRESS

The arbor press, shown above has been recently designed, and is built by Mr. F. J. Nutting, the sales being controlled by the Patterson Tool & Supply Co., Dayton, O. The feature of the open and shut nut, as clearly shown in the half-tone, gives this machine the desirable combination of a screw press having the advantages of a quick moving lever press. The bed of this press is 23 inches long by 12 inches wide, the frame being 27¾ inches high, or mounted on the legs, 4 feet 8 inches. The press will take in work 17 inches in diameter and the travel of the screw is 10½ inches, the distance from the bottom of the screw in the raised position to the notched segment being 11 5/16 inches.

MISCELLANEOUS TOOLS AND APPLIANCES.

The emery wheel dresser made by F. G. Marbach, Medina, O., is of the usual star-wheel type but with the wheels mounted on a slide designed to slip over the rest in front of the emery wheel. The dresser wheel is then fed up against the emery wheel by a cross slide, the main slide being held by one hand while the cross slide is being operated by the other hand of the workman.

An armature disk notching machine for small disks is built by Zeh & Hahnemann, Newark, N. J. The press is designed to do the work ordinarily done by one stroke by combination dies in a larger press, and where the number of disks to be turned out is not large answers every requirement, and the machine itself is much less expensive than the larger presses. There is, besides, a saving in the cost of the dies.

A 16-inch engine lathe has been placed on the market by the Fosdick Machine Tool Co., Cincinnati, O. This lathe is built either with a 5-step or a 3-step cone, the latter if desired for use with high speed steel. It has a modern arrangement of feed gears designed to give 40 changes and a screw cutting range from 2 to 56 threads per inch, and is equipped with compound rest. The main bearing is 2¾ inches in diameter.

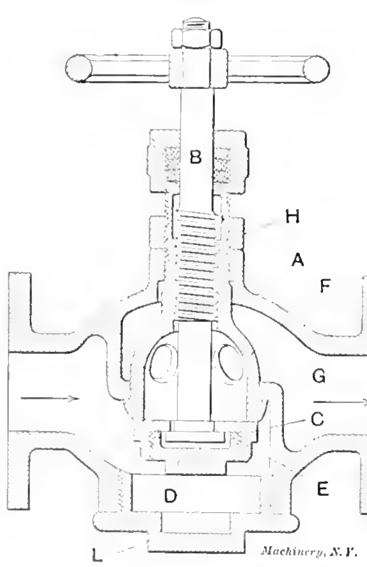
A water tool grinder made by the J. G. Blount Co., Everett, Mass., has a vertical centrifugal pump for flooding the wheel with water during grinding. The pump shaft is driven by means of a friction pulley which bears against the rim of the main driving pulley. The shaft runs in self-oiling bearings placed above the water-line. The pulleys are held in contact by a spring. A large water pan is placed below the wheel and collects the dirt and abrasive material coming from the wheel, and allows it to settle before the water is drained into the tank to which the pump is connected.

A tachometer of novel design is made by the Empire Machine Co., Pittsburg, Pa. The parts are contained in a small air-tight cylindrical case. The mechanism consists of a rotary fan driven by a train of gearing and a vane pivoted on the same axis as the fan, but entirely independent of the fan mechanism. A pointer attached to the vane is normally held at the zero position by a hair spring interposed between the rotary vane and a stationary part of the tachometer. The result is that the speed at which the fan is rotated will determine the position of the fan and the pointer, owing to the air current developed, and thus indicate the speed of the shaft or other rotating element that is being tested.

* * *

VALVE WITH REMOVABLE SEAT.

We show herewith a form of globe valve of novel design, as illustrated in the *Portfeuille Economique des Machines*,



Valve with Removable Seat.

for February, 1905. In most valves of this type the valve seat is fixed, so that when the parts become so badly worn that they cannot be reground in place, the whole valve casting must be carried to a machine tool for the necessary machining operations, which necessitates the breaking of the joint between the valve and the pipe.

In the valve shown, both the valve and the seat are removable. The body of the valve is divided into two compartments by a horizontal annular central partition, *G*, the ring being machined to receive the faced ledge or boss of the casting *A*. This piece *A* is screwed into the valve casing, and carries a check nut *H*.

The casting *A*, pierced with openings *F*, is traversed by the valve stem *B*, which carries the valve and is raised and lowered by the hand wheel; the cap placed on the top of *H* assures the tightness of the valve stem in the ordinary manner. The valve, properly speaking, is carried by the stem *B*. It is composed of two parts, *C* and *D*, screwed one into the other, to permit of their mounting upon the stem *B;* an asbestos joint *E* prevents any passage of steam between parts *C* and *D*. It is evident that to remove the pieces liable to wear from the valve, it is only necessary, after raising the hand wheel and removing the cover plate *L*, to unscrew the check nut from the part *A*. These pieces are all made perfectly interchangeable, and the replacing of any worn part should be very easy.

* * *

NEW PRESIDENT FOR LEHIGH UNIVERSITY.

At the meeting of the trustees of Lehigh University held at South Bethlehem, Pa., in June, Henry S. Drinker was elected president to succeed the late Dr. Thomas M. Drown. Mr. Drinker graduated from Lehigh in 1871 as an engineer of mines, and was in 1872 in charge of the construction of the Musconetcong Tunnel. Upon the completion of this, Mr. Drinker spent two years in the preparation of his well-known work upon tunneling, which is still considered the standard in its field. Shortly afterward Mr. Drinker was admitted to the bar. He is at present general solicitor for the Lehigh Valley Railroad, having served in that capacity for many years. Mr. Drinker has long been a trustee and active supporter of Lehigh University. His selection for the presidency, the acceptance of which entails personal sacrifices for Mr. Drinker, is eminently satisfactory to the trustees and alumni of the university.

* * *

CONCERNING NAME PLATES.*

So far as its operation is concerned, a dynamo or motor would be just as well off without a name plate as with one; yet there is probably no other part of the machine that is examined so carefully by visitors to a station or other interested persons not employed therein. And it is a matter of reasonable pride to the electrical engineer, being an indication of the thoroughness and precision with which his work has been done, that every piece of revolving and transforming apparatus for which he is responsible carries upon it this certificate of output ability, voltage, current, speed, etc. Of course, this is not the reason that name plates are put on dynamos, motors, converters, transformers, etc.; the chief object is to inform everyone interested in the matter just what the apparatus is intended to do, what its maximum output ability is and who made it (possibly the last-mentioned point should have been put first in the list). This method of imparting the information mentioned is not employed solely for the benefit of casual visitors, either; it is of prime importance to the operating staff of a station. It is not rational to expect employes to memorize the characteristics of every machine or important piece of apparatus about the plant, although most of them in time do so involuntarily, and it is highly essential that the fundamental data relating to any piece of apparatus shall be immediately available when required; the name plate meets this requirement perfectly—when it is properly made.

The foregoing argument applies just as forcibly to steam apparatus in an electric lighting or power plant as to the electrical equipment, yet no one ever saw a boiler name plate on which was stamped the number, diameter and length of the tubes, size of the grate, total area of heating surface, evaporating ability, etc.; nor does an engine name plate give the sizes

* *American Electrician*, June, 1905.

of the cylinders, most economical point of cut-off, rating in pounds of steam per horse-power-hour at this cut-off and a stated initial pressure, or any other technical information beyond the so-called horse-power and preferred speed. In the case of pumps, the makers have gone a little further ahead as to name plates and usually put on the cylinder sizes; it would be of considerable assistance to the user if the capacity in gallons per minute at the preferred speed were also put on, and the pressure for which the pump is designed might advantageously be included. The name plates on pumps for fire service are models of satisfaction in these particulars.

The point is that a great deal of valuable time is often lost by having to hunt up or calculate data which ought to be plainly stamped on the name plate of a piece of machinery; moreover, in the handling of machines equipped with incomplete name plates mistakes are made which would easily be avoided otherwise and which in some cases cause the machine to suffer disastrously for the petty sin of its builder.

* * *

FRESH FROM THE PRESS.

THE POCKETBOOK OF REFRIGERATION AND ICE MAKING. Edited by A. J. Wallis-Tayler. Published in America by the Norman W. Henley Publishing Co., 132 Nassau Street, New York. 184 pages, illustrated, pocketbook size. Price, $1.50.

The contents of this pocketbook comprise, among other matter, an outline of the subject of refrigeration; cold storage; ice making and the storing of ice; insulation; the testing and management of refrigerating machinery; general tables and memoranda. It was prepared with the idea of providing a pocket book which should contain such formulas, tables and data, with brief descriptive matter, as would prove useful to persons interested in refrigeration and cold storage. The matter is, to a large extent, in tabular form.

FERRIC AND HELIOGRAPHIC PROCESSES: A HANDBOOK FOR PHOTOGRAPHERS AND DRAFTSMEN. By George E. Brown. Published in America by Tennant & Ward, 287 Fourth Avenue, New York. 149 12mo. pages. Price, $1.00.

This little handbook is designed to serve two classes of people. First, amateur photographers, with a taste for experiment, who may like to make their own sensitive papers, and draftsmen, who have to make prints from tracings. It will doubtless appeal to the first class more in England, where the book is published, than in this country, but the information upon making various kinds of prints from tracings supplies a want in draftsmen's literature that, so far as we know, has not heretofore been met. The book first describes blueprinting processes and methods for toning blueprints to produce other colors than blue. Then follow the printing of blue lines on white ground, and the printing of black and brown lines on white ground, or white lines on black or brown ground. There are 22 chapters in all, going into the subject in much detail.

ALTERNATING CURRENT MACHINERY. By William Esty, S. B. and M. A., head of Department of Electrical Engineering, Lehigh University; American School of Correspondence, Armour Institute of Technology. Chicago: 1905. Pages, 412. Price, $3.75.

This volume has been prepared with the especial object of giving practical electricians and beginners a working knowledge of alternating current apparatus without the necessity of the readers understanding the higher mathematics. A rudimentary knowledge of algebra and trigonometry should be sufficient for the clear comprehension of the principles treated. The descriptions, explanations and proofs are simple and clear; graphical or geometric methods rather than analytical or algebraic have been adopted wherever possible. Many examples and numerical illustrations have been used throughout the text to reenforce the principles by their practical application. The reader is supposed to have some acquaintance with the simpler laws of electricity and magnetism.

The student is first acquainted with the essential features of the source of alternating currents, the alternator, and with the features of alternating current problems which differentiate them from direct current problems. After this a description of alternating current measuring apparatus follows. Several chapters are devoted to synchronous motors, the transformer, the rotary converter, the induction motor, station appliances and lightning arresters. In these descriptions the theory, applications, operations and structural detail of each class are described and illustrated.

The volume is well bound, printed on good paper, and is fully illustrated.

MACHINE TOOLS AND WORK SHOP PRACTICE. By Alfred Parr, Instructor in Fitting and Machine Shop, and Forge, University College, Nottingham; with an introduction by Wm. Robinson, Professor of Engineering, University College, Nottingham. 432 pages $5\frac{1}{2}$ x $8\frac{1}{2}$ inches. Illustrated with 462 cuts. Published by Longmans Green & Co., London and New York. Price, $4.00.

The introductory remarks by Prof. Robinson are of interest, especially that in which he speaks of the accuracy of modern measuring instruments. The assertion is made that with the ordinary Whitworth measuring machine differences of 1-100,000 inch or about 1-4,000 millimeter can be detected, but that the electric micrometer enables us to measure small dimensions and magnitudes of the order of 1-5,000,000 millimeter or 1-120,000,000 inch. This instrument reveals elevations on a plane surface or errors in a screw thread which no machine yet made can remove; an attempt at removal with ordinary means produces a hollow. The book takes up progressively the following subjects, one chapter for each: Measurement; Marking or Lining-Out and Processes; Materials; Drills and Drilling Machinery; Turret Lathes; Treadle and Power Lathes; Lathe Appliances; Boring Machines; Lathe Work; Grinding Wheels and Machines; Cold Iron and Steel Sawing Machines—Planing, Shaping and Slotting Machines; Milling Machines, Milling Cutters and Appliances; Gearing and Gear Cutters; Cutting Tools and How to Use Them; Fitting, Erecting and Vise Work and Tools; Forge Shop Tools and Forging Processes; Hydraulic Machine Tools and Riveting; Transmission of Power; Methods of Working; Appendix.

It should be obvious from the nationality of the author that the work treats generally of English practice, although this is by no means universally the case as a number of American machine tools are described and American small tools such as milling cutters and hand tools such as micrometers, levels, depth, gages, etc., are shown of American pattern. In fact in all works on English practice that we have examined the illustrations of small tools are almost invariably of the American pattern, and one is puzzled to know what small tools are representative of English manufacture, if any are. The chapter on measurement is of much interest, although we can hardly credit the statement made in the introductory notes by Prof. Robinson on the marvelous refinement now possible by electric touch. In this chapter a very good resume is given of the Brown & Sharpe Mfg. Co.'s duplication of the standard yard by Mr. Oscar J. Beale, and the chapter, as a whole, is a compliment to the work of Brown & Sharpe in the matter of fine measuring instruments. Lack of space prohibits a thorough review of the work and we must limit ourselves to the general statement that it is of general worth to almost anyone interested in machine shop practice and the general art of manufacturing.

NEW TRADE LITERATURE.

In the last number of MACHINERY the price list of "Boldi Steel" sold by Peter Frasse & Co., New York, was referred to; it should have been "Poldi Steel."

THE WASHBURN SHOPS, Worcester, Mass. Circular of adjustable drawing stands for draftsmen, students, etc.

THE BULLARD MACHINE TOOL CO., Bridgeport, Conn. Circular entitled "One Day's Work," showing what can be done in turning piston rings on a Bullard mill.

HYATT ROLLER BEARING CO., Harrison, N. J. Bulletin containing fac-simile letters from prominent users, expressing approval of the Hyatt roller bearings and giving reasons therefor.

MARSHALL & HUSCHART MACHINERY CO., 62-64 So. Canal St., Chicago, Ill. Illustrated sheets containing descriptions of various machine tools handled by this firm; the sheets are perforated and designed to be bound into covers for their preservation and convenient reference.

THE ELECTRIC CONTROLLER & SUPPLY CO., Cleveland, O. Catalogue of lifting magnets. These magnets are of various designs according to the kind of material and the weight of material handled, and the catalogue contains information upon these several types and explains the practical points connected with their use.

C. W. HUNT CO., 45 Broadway, New York City. Catalogue No. 054 upon manila rope transmission and hoisting. This pamphlet, besides being a catalogue of the rope transmission systems built by this company, is also a treatise on the subject of rope transmission, containing valuable data by Mr. C. W. Hunt.

WELLMAN-SEAVER-MORGAN CO., Cleveland, O. Illustrated catalogue of coal-handling machinery. This is one of the finest catalogues we have received and it explains in detail and with numerous fine engravings the remarkable progress that has been made in recent years in handling coal at the mines, docks and in storage.

YALE & TOWNE MFG. CO., 9-15 Murray St., New York. Two catalogues, one dealing with the Yale & Towne chain blocks and electric hoists and the other with locks and hardware for railroad use, especially for railroad cars and stations. A feature of the first pamphlet is a folder map of New York City, showing the route of the subway.

THE MORTON MFG. CO., Muskegon Heights, Mich. Catalogue of draw-cut shapers. These well-known shapers have been developed along original lines for numerous classes of work, ranging from ordinary work that is done on pillar shapers to heavy railroad work and floor-plate work requiring portable tools. This catalogue describes these various lines and illustrates many of the machines.

BROWN & SHARPE MFG. CO., Providence, R. I. Illustrated circular of their new No. 12 Automatic Gear Cutting Machine, which is illustrated in this number of MACHINERY. Also, illustrated circular of the new machinists' tools, including a micrometer set in sizes up to 6 inches, steel beam trammels, universal dividers, straightedges, and scribers.

CINCINNATI MACHINE TOOL CO., Cincinnati, O. Catalogue of upright drilling and tapping machines. Drills manufactured by this company are made in sizes from 21 to 42 inches and in a variety of styles. They are built either with or without reversing arrangement for the spindle to be used in tapping. Certain styles are fitted with an improved positive geared feed with quick change.

CROCKER-WHEELER CO., Ampere, N. J. Illustrated circular of railway generators, comprising a description of various installations and data upon generators in sizes up to 1,500 K. W. Also, illustrated pamphlet with a complete description of the electrical equipment of the Pittsburg & Lake Erie R. R., written by Roy V. Wright, formerly mechanical engineer of these shops and now associate editor of the *American Engineer and Railroad Journal.*

INTERNATIONAL STEAM PUMP CO., 114 Liberty St., New York. A large pamphlet describing a complete line of steam, electric, gas and power-driven compressors of different types is being distributed by the Laidlaw-Dunn-Gordon branch of this company. One of the features of this pamphlet is a notice of the improved system of air-valve gears. It also explains the air-lift for raising water from driven or bored wells and gives much engineering data.

MORSE TWIST DRILL & MACHINE CO., New Bedford, Mass. Pamphlet entitled "Young Machinist's Practical Guide." This contains 45 pages devoted to tables of practical use to machinists, especially in regard to drills and milling cutters. There are numerous other tables, however, such as the weight of metals, data upon threads, etc. This will be sent to any one sending his name and address, but it is requested that the full address be clearly written since their experience has been, in their previous offers to machinists, that the addresses are frequently insufficient to enable them to fill the order.

NORTHERN ELECTRICAL MANUFACTURING CO., Madison, Wis., have issued Bulletin No. 44, which illustrates representative applications of their back-geared motors in industrial plant service. Slow speed for all sorts of machines is readily provided by Northern back-geared motors. The back-geared attachment is a compact, self-contained device which turns the driving shaft at slow speed without the necessity of employing a motor designed for slow armature speed. In other words, the ordinary high-speed armature is employed, which means a motor of low cost for slow speed machines.

CINCINNATI MILLING MACHINE CO., Cincinnati, O. Illustrated "Treatise on Tool Room Grinding and Grinding Machines," containing a great deal of valuable information upon the subject of cutter and tool grinding. Part 1 is devoted to the No. 1 Universal Cutter and Tool Grinder which has been manufactured for a long time; and Part 2 to the No. 2 Grinder, which is a new one and is a complete universal grinder for cutter and tool grinding from the smallest cutter up to face mill 24 inches diameter. Numerous illustrations show how to handle a great variety of work and the description in connection with the illustrations gives valuable information upon cutter grinding, applicable to all such work regardless of the make of machine used. The book is sent free of charge to those interested in the subject.

The Lackawanna has just issued, through its Industrial Department, a little booklet containing comprehensive information about factory buildings either new or vacant or available for manufacturing and industrial enterprises, located in territory served by that road in New York, New Jersey and Pennsylvania. A description is given of each building, its present equipment, and whether or not it is served by private sidetrack, together with some general information as to the town in which it is located. For those contemplating the organization of a new industry or the re-location of one already established, the book contains many suggestions that may prove of interest. Copies of this booklet may be had free upon application to Wendell P. Colton, Industrial Agent, 26 Exchange Place, New York City.

Vol. 3. No. 12 ENGINEERING EDITION Adv. Index Pages 20–23

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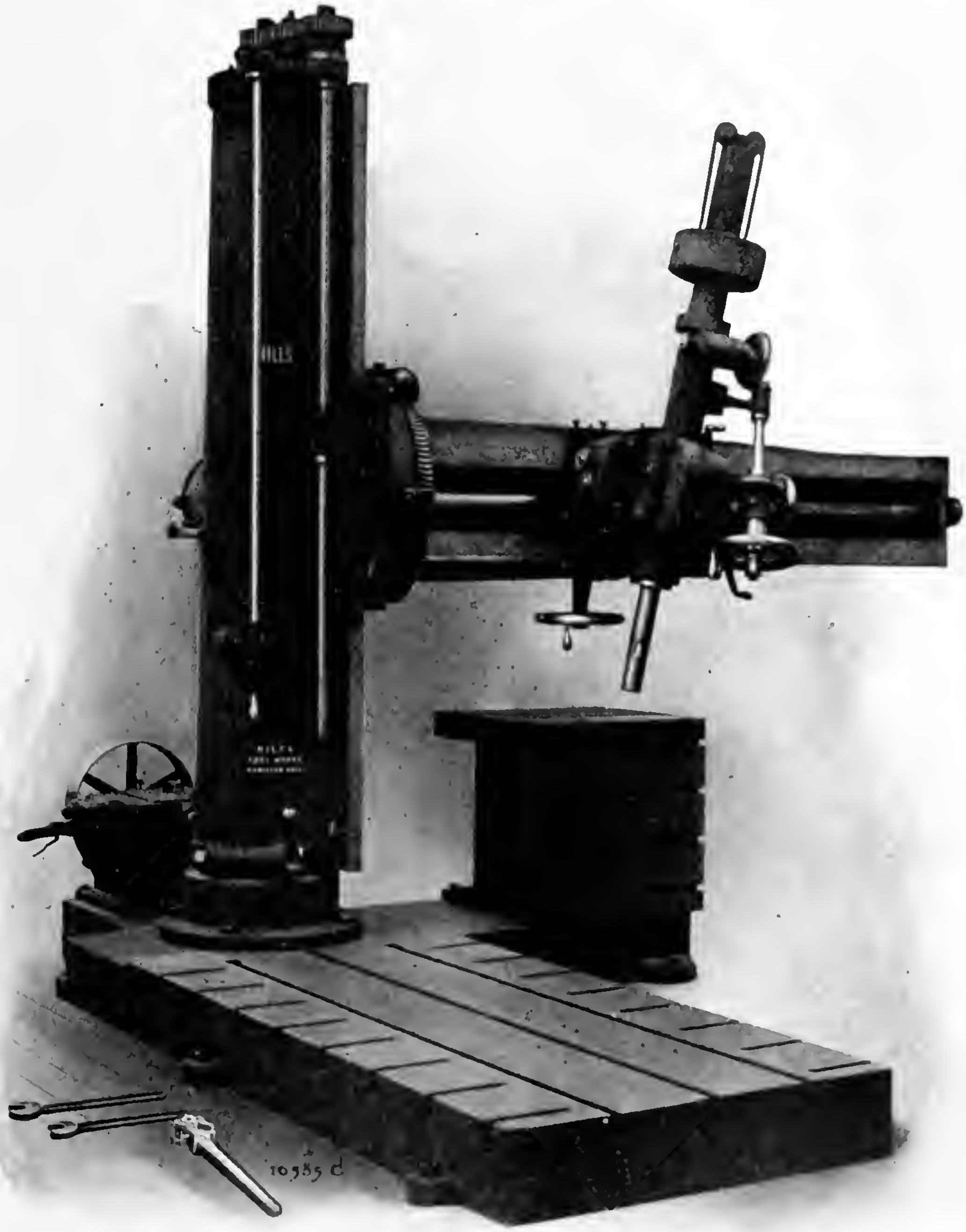

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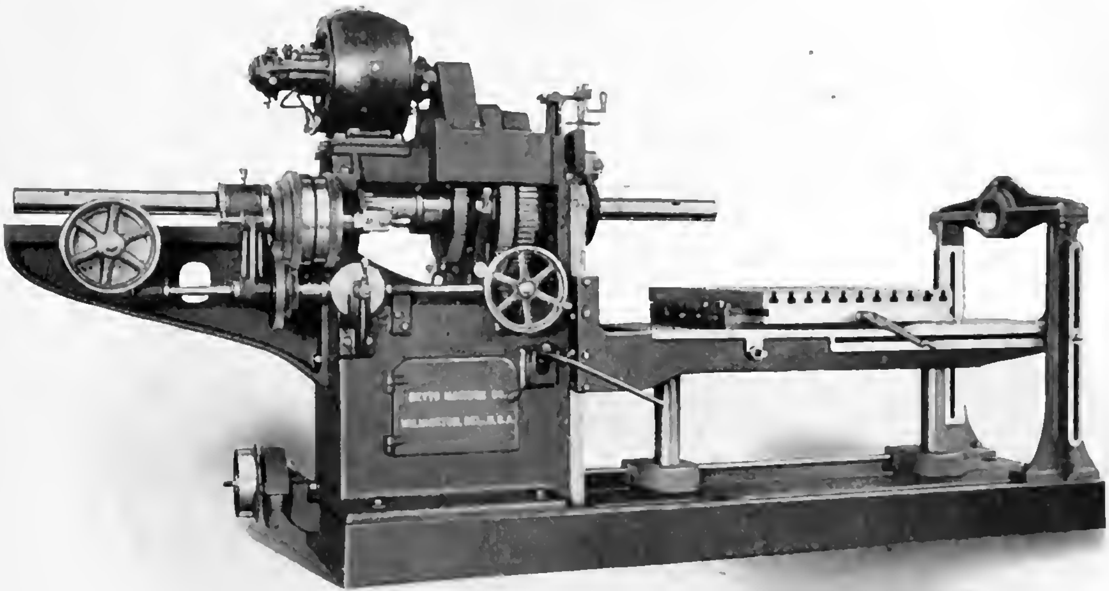

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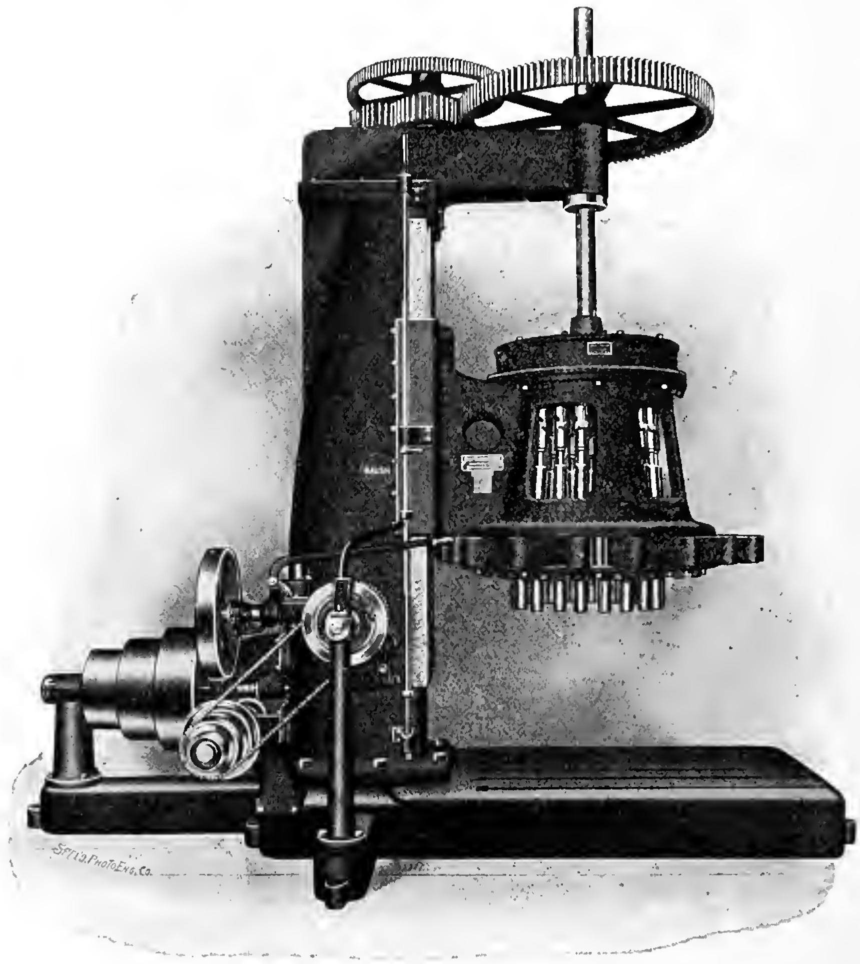

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Technical Department II. Headquarters for American Machinery. Metal and Wood Working Machinery. Established 1847. Telegraphic Address, METALLICUS, Rotterdam.

VAN RIETSCHOTEN & HOUWENS, ROTTERDAM, HOLLAND.
Headquarters for American Machinery
in Holland. Telegraphic address: "Machinery." Codes used: A B C, 4th edition; Liebers; Atlantic Cable Directory.

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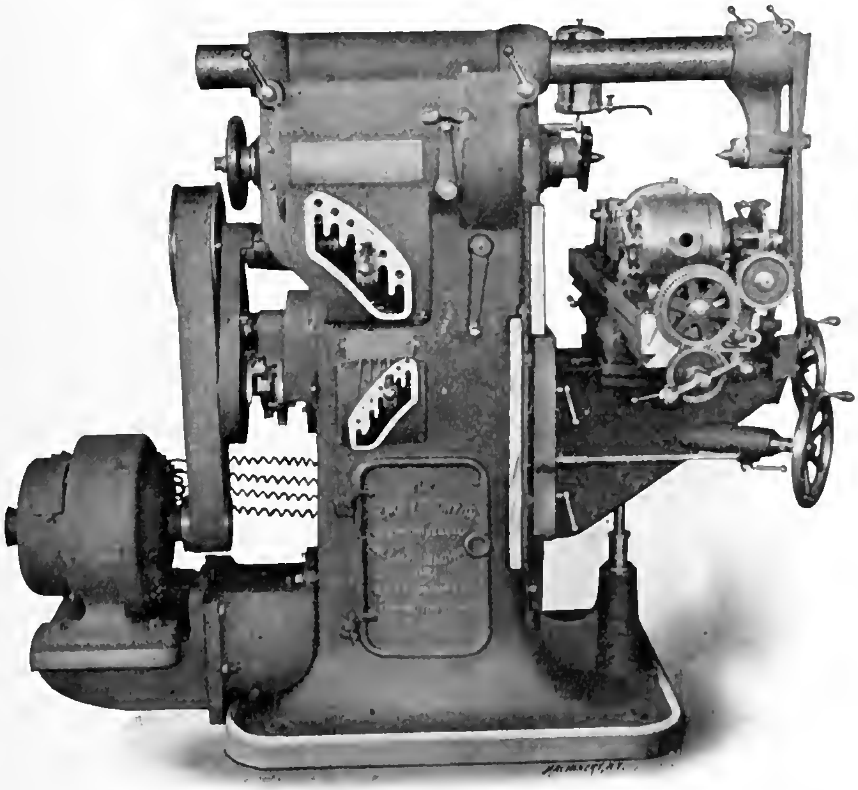

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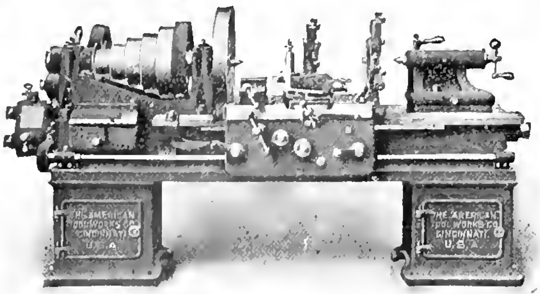

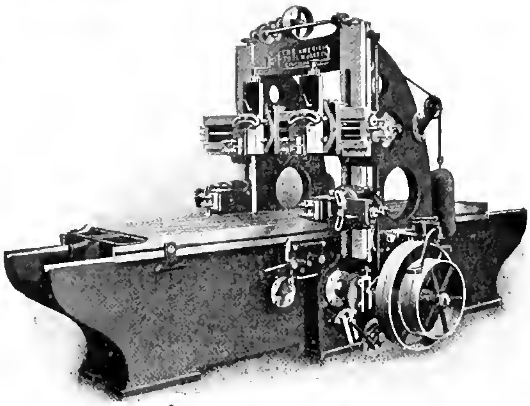

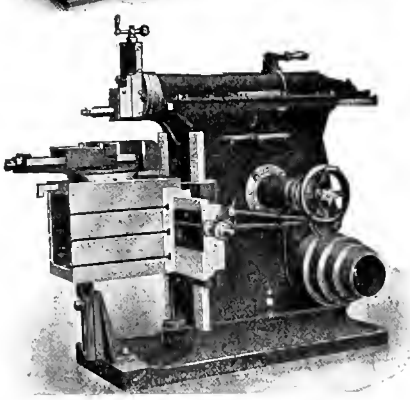

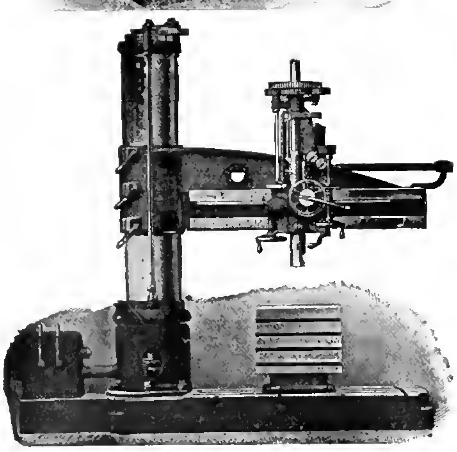

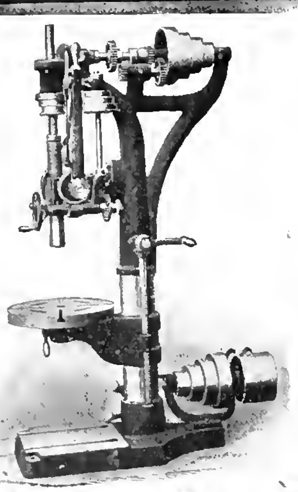

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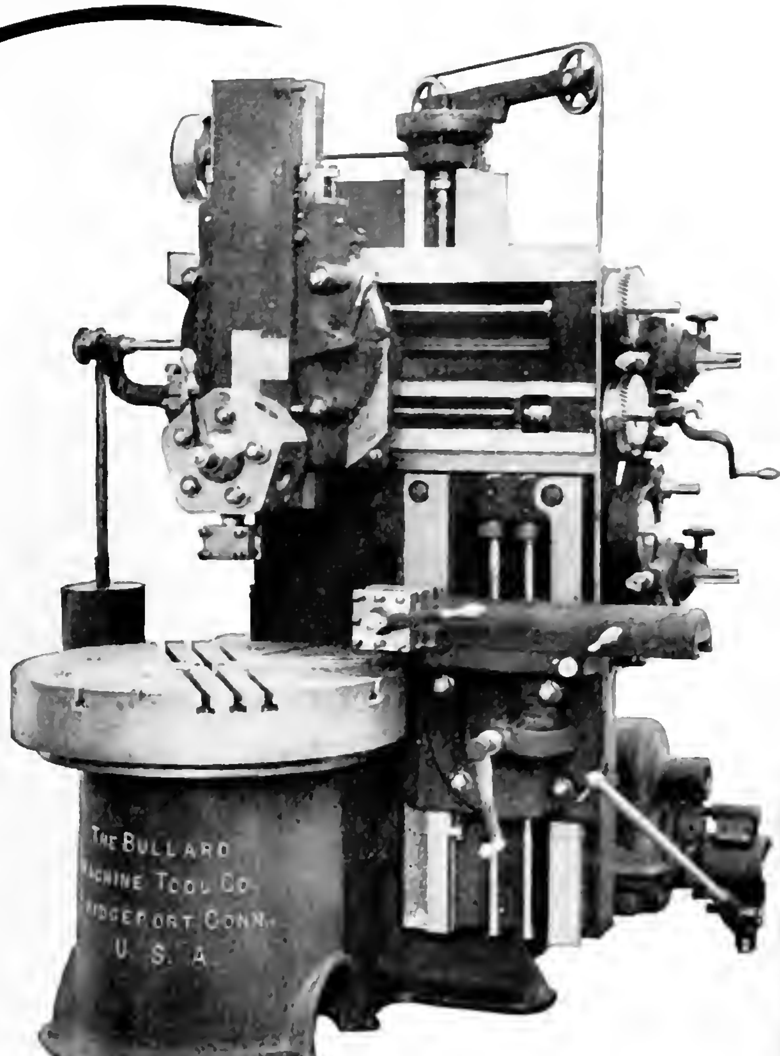

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Alphabetical Index of Advertisers.

Abrasive Material Co. 98
Acme Machinery Co. 27
Adams Co. 96
Affleck, Geo. E. 104
Almond, T. R., Mfg. Co. ... 115
American Ball Co. 115
American Blower Co. 85
American Gas Furnace Co. .. 98
American Pulley Co. 112
American Tool Works Co. ... 14
Andrew, M. L., & Co. 97
Arguto Oilless Bearing Co. .. 79
Armstrong Bros. Tool Co. ... 47
Armstrong Mfg. Co. 120
Arthur Co. 108
Athol Machine Co. 114
Atlas Mch. Co. 105
Auburn Ball Bearing Co. 101
Audel, Theo., & Co. 106

Baird, Henry Carey & Co. .. 106
Baird Machinery Co. 104
Baker Bros. 82
Balkwill Pattern Wks. 100
Ball Bearing Co. 116
Bantam Anti-Friction Co. ... 108
Bardons & Oliver 62
Barnes, B. F., Co. 79
Barnes, W. F. & J., Co. 56
Barnett, G. & H., Co. .Back cover
Barr, H. G. 95
Bath Grinder Co. 106
Baush Mchy. & Supply Co., Back cover
Baush Mch. Tool Co. 8
Bay State Stamping Co. 31
Beaman & Smith Co. 15-117
Beaudry & Co. 110
Becker-Brainard Milling Mch. Co. 71
Bemis & Call, H. & T., Co., Inside front cover
Bertsch & Co. 119
Besly, Chas. H., & Co. 59
Betts Mch. Co. 7
Bickford, H., & Co. ..Back cover
Bickford Drill & Tool Co. ... 64
Bignall & Keeler Mfg. Co. .. 81
Bilgram, Hugo 108
Billings & Spencer Co. 34
Binsse Machine Co. 11
Birdsboro Steel Fdry. & Mch. Co. 23
Bissell, F., Co 31-104
Blanchard Mch Co. 24
Bliss, E. W., Co. 33
Boston Gear Works 108
Bowsher, N. P., Co. 107
Bradford Mch. Tool Co. 9
Bradley, C. C., & Son 110
Bridgeport Safety Emery Wheel Co. 107
Brown, H. B., Co. 121
Brown, R. H., & Co. 116
Brown-Cochran Co. 105
Brown & Sharpe Mfg. Co. ... 35
Browning Engineering Co. .. 99
Builders' Iron Foundry, Back cover
Bullard Mch. Tool Co. 19
Bultman, F. H., & Co. 108
Burke Mchy. Co. 119
Burnham, Royal E. 103
Burr, J. T., & Sons 89
Butler, A. G. 101
Butterfield & Co. 31

Calder, Geo. H. 106
Caldwell, H. W., & Son Co. .. 80
Carborundum Co. 106
Card, S. W., Mfg. Co. 115
Carlyle Johnson Mch. Co. ... 112
Carpenter, J. M., Tap & Die Co. ....Back cover
Carr Bros. 100
Carter & Hakes Mch. Co. ... 115
Chambersburg Eng. Co. 111
Chicago Flexible Shaft Co. .. 92
Cincinnati Mch. Tool Co. 34
Cincinnati Milling Mch. Co. 37
Cincinnati Planer Co. 78
Cincinnati Punch & Shear Co 28
Cincinnati Shaper Co. 66
Clapp, E. D., Mfg. Co. 110
Clark, Jas., Jr., & Co.Back cover
Cleveland Auto. Mch. Co. ... 57
Cleveland Twist Drill Co., Back cover
Cling-Surface Co. 113
Coates Clipper Mfg. Co. 95
Coburn Trolley Track Mfg. Co. 61
Cochrane Bly Co. 102
Coes Wrench Co. 34-52
Colburn Mch. Tool Co. 87
Columbus Machine Co. 120
Cook, Asa S., Co. 94
Corrugated Grinding Wheel Co. 106
Crane Co. 115 121
Crocker-Wheeler Co. 50
Cullman Wheel Co. 108
Curtis & Curtis Co. 120
Curtis & Co. Mfg. Co. 84
Cushman Chuck Co. 115
Cutler-Hammer Clutch Co. .. 51

Davis, Frank M., & Co. 103
Davis, W. P., Mch. Co. 42
De Laval Steam Turbine Co. 118
Desmond-Stephan Mfg. Co. .. 107
Detrick & Harvey Mch. Co. .. 16
Detroit Twist Drill Co. 28
Diamond Chain & Mfg. Co. .. 24
Diamond Mch. Co. ...Back cover
Diamond Saw & Stamping Works 89
Dickinson, Thos. L. 98
Dienelt & Eisenhardt 110
Dietzgen Co., Eugene 102
Dill, T. C., Mch. Co. 49
Dixon, Jos., Crucible Co. 118
Dreses Mch. Tool Co. 83
Duff Mch. Co. 120
Dunn & Turk 103
Dwight Slate Mch. Co. 74

Easton Polishing Supply Co. 107
Eaton, Cole & Burnham Co. 26-29
Earle Gear & Mch. Co. 109
Eberhardt Bros. Mch. Co. ... 108
Eck Dynamo & Motor Works 105
Elec. Controller & Sup. Co. .. 50
Electro-Dynamic Co. 49
Elgin Tool Wks. 100
Elmes, Chas. F., Eng'r'g Wks. 29
Emmert Mfg. Co. 114
Englehard, Chas. 30
Erie Forge Co. 82
Espen-Lucas Mch. Wks. 89
Evans, G. F. 113

Fay & Scott 87
Fellows Gear Shaper Co. ... 93
Flather & Co. 94
Flather, Mark, Planer Co. .. 26
Foos Gas Engine Co. 105
Foote Bros. Gear & Mch. Co. 108
Foote, Burt, & Co. 109
Foote, Pierson & Co. 65
Foreign Machinery Merchants 12
Fox Machine Co. 33 79
Franklin Mfg. Co. 22
Franklin Portable Crane & Hoist Co. 32
Frasse, P. A., & Co. 26
Fritz & Goeldel Mfg. Co. 103
Fuchs & Lang Mfg. Co. 108

Ganschow, Wm. 108
Gas Engine Publishing Co. .. 105
General Pneumatic Tool Co. 80
Geometric Tool Co. 117
Giant Motor Co. 105
Gilmer, L. H., & Co. 91
Gisholt Machine Co. 10
Gleason Works, Front cover-Back cover
Globe Mch & Stamping Co. .. 31
Goddard Mch. Co. 106
Goldschmidt-Thermit Co., Inside front cover
Goodell-Pratt Co 93
Gould & Eberhardt 53
Graham Mfg. Co 114
Grant Gear Works 108
Grant Mfg. Co. 121
Gray, G. A., Co Inside front cover
Greaves, Klusman & Co. 98
Guarantee Electric Co. 105

Hamilton Mch. Tool Co. 62
Hammacher, Schlemmer & Co. 39
Hampden Corundum Wheel Co. 107
Hart Mfg. Co 24
Hay-Budden Mfg. Co. 31
Hayes File Co. 26
Heald Machine Co. 89
Heller Bros. Co. 30
Hendey Mch. Co. 13
Henley, Norman W., & Son .. 41
Henry, F. G. 103
Henry & Wright Mfg. Co. 63
Hill-Standard Mfg. Co. 91
Hisey-Wolf Mch. Co. 22
Hoefer Mfg. Co. 85
Hoffman, Geo. W. 120
Hoggson & Pettis Mfg. Co. .. 117
Hoist Mfg. & Construction Co. 102
Holroyd & Co. 21
Horsburg & Scott Co 108
Horton, E., & Son Co. 116
Howson & Howson 103
Hurlburt-Rogers Mch. Co. .. 122

Industrial Novelty Co. 31
Ingersoll Milling Mch. Co. ... 54
Ingersoll-Sergeant Drill Co. 86
International Corr. Schools. 17
International Power Vehicle Co. 105
International Specialty Co. . 103

Jacobs Mfg. Co. 116
Jacobson Mch. Mfg. Co. 105
Jeffrey Mfg. Co. 113
Jenkins Bros. 119
Jessop, Wm., & Sons, Ltd. . 30
Jones & Lamson Mch. Co. ... 69

Kelly, R. A., Co. 97
Kempsmith Mfg. Co. 86
Kent, Edwin R., & Co. 30
Keuffel & Esser Co. 102
Keystone Drop Forge Works 110
Kilbourne & Jacobs Mfg. Co. 88
King Mch. Tool Co. 109
Knecht Bros. Co. 34
Krips-Mason Mch. Co. 119

Landis Tool Co. 40
Le Blond Mch. Tool Co. 21-63
Link Belt Engineering Co. ... 80
Lobdell Car Wheel Co. 113
Lodge & Shipley Mch. Tool Co. 6
Long & Allstatter Co. 90
Lovejoy Co. 102
Lucas Mch. Tool Co. 95
Lufkin Rule Co. 28
Lutz Tool Mfg. Co. 75

Main Belting Co. 113
Manning, Maxwell & Moore. 65
Maris Bros. 58
Mason, Volney W., & Co. ... 118
Mattison, Jas. D. 89
McCabe, J. J. 60
McCullough-Dalzell Crucible Co. 122
M'Gieban, C. H., & Co. 26
Merrell Mfg. Co. 121
Merrill Bros. 114
Merritt & Co. 101
Milwaukee Fdry. Sup. Co. .. 111
Millers Falls Co. ....Back cover
Miner & Peck Mfg. Co., Back cover
Mitts & Merrill 60
Modern Tool Co. 117
Moline Tool Co. 94
Morse Chain Co. 81
Morse, Williams & Co. 109
Morse Twist Drill & Mch. Co. 68
Morton Mfg. Co. 97
Motch & Merryweather Mchy. Co. 105
Mueller Mch. Tool Co. 96

Nash, Geo. & Co. 74
National-Acme Mfg. Co. 27
National Machinery Co. 22
National Mch. Tool Co. 98
National Separator & Mch. Co. 101
National Twist D. & T. Co. . 100
New Britain Mch. Co. 103
New Doty Mfg. Co. 67
New Haven Mfg. Co. 97
New Process Raw Hide Co. 76-77
Newton Machine Tool Works 48
New York Belting & Packing Co. 18
Nicholson, W. H., & Co. 100
Nicholson File Co. 34
Niles-Bement-Pond Co. .4-5-94-104
Northern Electrical Mfg. Co. 50
Northern Engineering Works 84
Norton Emery Wheel Co. 47
Norton Grinding Co. 46

Obermayer, S., Co. 85
Ohio Pulley Co. 112
O. K. Tool Holder Co. 84
Olney & Warrin 97
Oneida National Chuck Co. . 115
Oster Mfg. Co. 119
Otto Gas Engine Works 105

Pawling & Harnischfeger ... 84
Paxson, J. W., Co. 101
Pedrick & Ayer Co. 90
Pedrick-Smith Co. 119
Peerless Rubber Mfg. Co. .. 18
Penn Pattern Wks. 103
Philadelphia Gear Wks. 108
Philips Pressed Steel Pulley Works 84
Phosphor Bronze Smelting Co. 30
Pittsburg Blue Print Co. 102
Poole Eng'r'g & Mch. Co. ... 113
Poole, J. Morton, Co. 86
Potter & Johnston Mch. Co. 83
Pratt Chuck Co. 116
Pratt Institute 99
Pratt & Whitney Co. 4
Prentice Bros. Co. Inside back cover
Prentiss Tool & Supply Co. .. 64
Prentiss Vise Co. 114

Quint, A. E. 96

Rand Drill Co. 87
Reed, F. E., Co. 3
Reed, Francis Co. 97
Reed Mfg. Co. 114
Reeves Pulley Co. 84
Reichhelm, E. P., & Co. 55
Reliance Mch. & Tool Co. 120
Rich, Geo. R., Mfg. Co. 115
Richards, I. P. 119
Ridgway Dynamo & Engine Co. 49
Rivett-Dock Co. 122
Rivett Lathe Mfg. Co. 122
Rogers, J. M., Boat, Gauge & Drill Works 61
Rogers & Hubbard Co. 30
Royersford Foundry & Mch. Co. 91

Safety Emery Wheel Co. 107
Saginaw Mfg. Co. 112
Saunders', D., Sons 121
Sawyer Tool Mfg. Co. 74
Schellenbach & Radcliffe 28
Schumacher & Boye 16
Schwerdtle Stamp Co. 100
Scranton & Co. 111
Sebastian Lathe Co. 98
Second-Hand Machinery 104
Sellers, Wm., & Co., Inc. ... 82
Seneca Falls Mfg. Co. 94-99
Sibley Mch. Tool Co. 96
Skinner Chuck Co. 117
Slocomb, J. T., Co. 75
Smith, E. G. 101
Smith, J. D., Fdry. Sup. Co., Back cover
Smith & Mills 97
Snyder, J. E., & Son 3
Spacke, F. W., Mch. Co. 86
Spear, Middleton, Donaldson & Spear 103
Springfield Mch. Tool Co. ... 44
Standard Engineering Co. ... 121
Standard Gauge Steel Co. ... 82
Standard Pressed Steel Co. . 110
Standard Roller Bearing Co. 33-116
Standard Tool Co. 43-92
Standard Welding Co. 73
Stark Tool Co. 89
Starrett, L. S., Co. 70
Steel Set Diamond Co. 98
Steffey Mfg. Co. 105
Steptoe, John, Shaper Co., Inside front cover
Sterling Emery Wheel Mfg. Co. 106
Stevens, Milo B., & Co. 103
Stewart Heater Co. 118
Stockbridge Machine Co. 96
Stoever Fdry. & Mfg. Co. ... 120
Story, H. T. 114
Stow Flexible Shaft Co. 120
Stow Mfg. Co. 99
Sturtevant, B. F., Co. 51
Sutton, C. E., Co. 91
Syracuse Twist Drill Co. 114

Tabor Mfg. Co. 89
Three Rivers Tool Co. 29
Toledo Machine & Tool Co. . 103
Toomey, Frank 104
Trimont Mfg. Co. 85
Trump Bros. Mch. Co. 99
Tucker, W. M. & C. F. 31
Turner Brass Wks. 31

Underwood, H. B., & Co. 3
Union Twist Drill Co. 46
U. S. Elec. Tool Co. 25

Valley Iron Works 29
Van Dorn & Dutton Co. 108
Vitrified Wheel Co. 107
Von Wyck Mch. Tool Co. ... 94

Wagenhorst, J. H., & Co. 102
Walcott, Geo. D., & Son 72
Walker Grinder Co. ..Back cover
Wallace Supply Co. 121
Waltham Watch Tool Co. ... 99
Warner Instrument Co. 67
Warner & Swasey Co. 32
Waterbury-Farrel, F. & M. Co. 34
Watson-Stillman Co. 90
Westcott Chuck Co. 116
Western Tool & Mfg. Co. ... 100
West Haven Mfg. Co. 88
Westinghouse Elec. & Mfg. Co. 49
Whitcomb-Blaisdell Mch. Tool Co. 45
Whitman & Barnes Mfg. Co. 101
Whitney Mfg. Co. 76
Whiton, D. E., Mch. Co. 66
Whittlesey, Geo. P. 103
Wiley, John, & Sons 34
Wiley & Russell Mfg. Co. ... 75
Williams Elec. Mch. Co. 88
Williams, J. H., & Co. 111
Williams Tool Co. 121
Wilmarth & Morman Co. ... 96
Wilson, W. A., Mch. Co. 34
Windsor Mch. Co. 78
Winkley Co. 31
Witteman, A. P., & Co. 101
Woodman, R., Mfg. & Supply Co. 118
Wood's Sons, T. B. 112
Wyke, J., & Co. 115
Wyman & Gordon, Inside front cover

Yale & Towne Mfg. Co. 80

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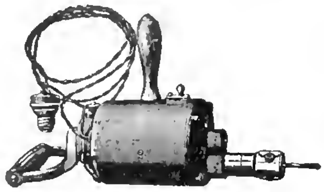

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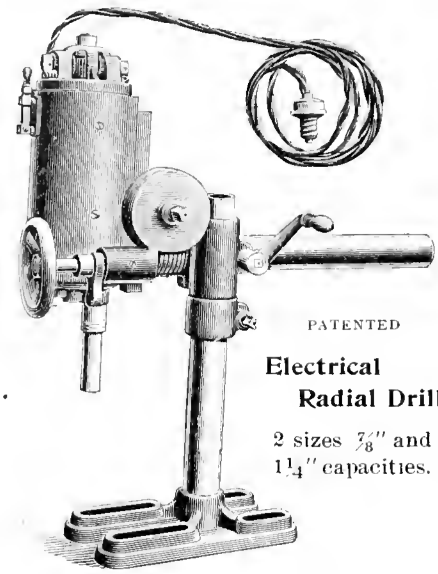

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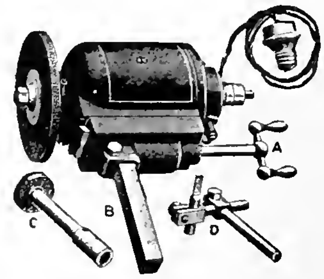

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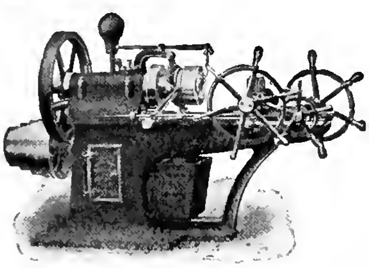

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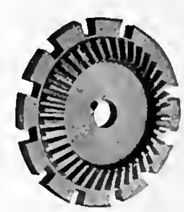

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Classified Index to Advertisements.

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Jacobson Mch. Mfg. Co., Warren, Pa.
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Seneca Falls Mfg. Co., Seneca Falls, N. Y.

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Auburn Ball Bearing Co., Rochester, N. Y.
Ball Bearing Co., Philadelphia, Pa.
Bantam Anti-Friction Co., Bantam, Conn.
Standard Roller Bearing Co., Philadelphia, Pa.

Balls, Steel.
American Ball Co., Providence, R. I.
Ball Bearing Co., Philadelphia, Pa.
Standard Roller Bearing Co., Philadelphia, Pa.

Barrows.
Kilbourne & Jacobs Mfg. Co., Columbus, O.

Belt Filler.
Cling-Surface Co., Buffalo, N. Y.

Belting.
Gilmer, L. H., & Co., Philadelphia.
Main Belting Co., Philadelphia, Pa.

Belting, Rubber.
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Belt Lacing Machines.
Birdsboro Steel Fdry. & Mch. Co., Birdsboro, Pa.

Bending Tools, Hand.
Wallace Supply Co., Chicago, Ill.

Blowers.
American Blower Co., Detroit, Mich.
De Laval Steam Turbine Co., Trenton, N. J.
B. F. Sturtevant Co., Hyde Park, Mass.

Blue Print Machines.
Eugene Dietzgen Co., Chicago, Ill.
Keuffel & Esser Co., New York.
Pittsburg Blue Print Co., Pittsburg, Pa.
Wagenhorst, J. H. & Co., Youngstown, O.

Bolt Cutters.
Acme Machinery Co., Cleveland, O.
Brown, H. B., Co., East Hampton, Conn.
Detrick & Harvey Mch. Co., Baltimore, Md.
National Mchy. Co., Tiffin, O.
Pratt & Whitney Co., Hartford, Conn.
Reliance Mch. & Tool Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt and Nut Machinery.
Acme Machinery Co., Cleveland, O.
Brown, H. B., Co., East Hampton, Conn.
Detrick & Harvey Mch. Co., Baltimore, Md.
Grant Mfg. Co., Bridgeport, Conn.
National Mchy. Co., Tiffin, O.
Standard Engineering Co., Ellwood City, Pa.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.

Boring Bars.
Pedrick & Ayer Co., Plainfield, N. J.
H. B. Underwood & Co., Philadelphia, Pa.

Boring Machines.
Beaman & Smith Co., Providence, R. I.
Betts Mch. Co., Wilmington, Del.
Binsse Mch. Co., Newark, N. J.
Davis, W. P., Mch. Co., Rochester, N. Y.
Detrick & Harvey Mch. Co., Baltimore, Md.
King Mch. Tool Co., Cincinnati, O.
Lucas Mch. Tool Co., Cleveland, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Pond Mch. Tool Co., New York.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.

Boring Mills.
Baush Mch. Tool Co., Springfield, Mass.
Betts Mch. Co., Wilmington, Del.
Bickford, H., & Co., Lakeport, N. H.
Bullard Mch. Tool Co., Box 3051, Bridgeport.
Colburn Mch. Tool Co., Franklin, Pa.
Gisholt Mch. Co., Madison, Wis.
Pond Mch. Tool Co., New York.
Poole, J. Morton, Co., Wilmington, Del.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Three Rivers Tool Co., Three Rivers, Mich.
Warner & Swasey Co., Cleveland, O.

Boring Tools.
Armstrong Bros. Tool Co., Chicago, Ill.
Carr Bros., Syracuse, N. Y.
Cleveland Twist Drill Co., Cleveland, O.
Hill-Standard Mfg. Co., Anderson, Ind.

Bulldozers.
National Mchy. Co., Tiffin, O.

Cabinets, Blue Prints.
Fritz & Goeldel Mfg. Co., Grand Rapids, Mich.

Calipers. (See Machinists' Small Tools.)

Carborundum Wheels.
Carborundum Co., Niagara Falls, N. Y.

Case Hardening.
Rogers & Hubbard Co., Middletown, Conn.

Castings.
Erie Forge Co., Erie, Pa.
Fuchs & Lang Mfg. Co., New York.
Lobdell Car Wheel Co., Wilmington, Del.
Phosphor Bronze Smelting Co., Philadelphia, Pa.

Castings, Finished.
Franklin Mfg. Co., Syracuse, N. Y.

Center Grinders.
Heald Mch. Co., Worcester, Mass.
Hisey-Wolf Mch. Co., Cincinnati, O.
Trump Bros. Mch. Co., Wilmington, Del.

Centering Machines.
Springfield Mch. Tool Co., Springfield, O.
D. E. Whiton Mch. Co., New London, Conn.

For Alphabetical Index, see Page 20.

Classified Index to Advts. (Continued).

Chains.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., Columbus, O.

Chains, Driving.
Morse Chain Co., Trumansburg, N. Y.

Chain Blocks, Differential, Duplex and Triplex.
Yale & Towne Mfg. Co., New York.

Chucks.
T. R. Almond Mfg. Co., Brooklyn, N. Y.
R. H. Brown & Co., New Haven, Conn.
Cushman Chuck Co., Hartford, Conn.
E. Horton & Son Co., Windsor Locks, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mch. Co., New Bedford.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt Chuck Co., Frankfort, N. Y.
Francis Reed Co., Worcester, Mass.
Rich, Geo. R., Mfg. Co., Buchanan, Mich.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Westcott Chuck Co., Oneida, N. Y.
D. E. Whiton Mch. Co., New London, Conn.
Whitney Mfg. Co., Hartford, Conn.

Clutches, Electric.
Williams Elec. Mch. Co., Akron, O.

Clutches, Friction.
H. W. Caldwell & Son Co., Chicago.
Carlyle Johnson Mch. Co., Hartford, Conn.
Jacobson Mch. Mfg. Co., Warren, Pa.
Wood's Sons, T. B., Chambersburg, Pa.

Clutches, Magnetic.
Cutler-Hammer Clutch Co., Milwaukee, Wis.
Elec. Controller & Supply Co., Cleveland, O.

Cold Saw Cutting-off Machines.
Birdsboro Steel Fdry. & Mch. Co., Birdsboro, Pa.
John T. Burr & Son, Brooklyn, N. Y.
Hill-Standard Mfg. Co., Anderson, Ind.

Controllers.
Elec. Controller & Supply Co., Cleveland, O.

Core Ovens.
S. Obermayer Co., Cincinnati, O.

Coupling.
W. P. Davis Mch. Co., Rochester, N. Y.
Wood's Sons, T. B., Chambersburg, Pa.

Cranes.
Browning Engineering Co., Cleveland, O.
Coburn Trolley Track Mfg. Co., Holyoke, Mass.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Franklin Portable Crane & Hoist Co., Franklin.
General Pneu. Tool Co., Montour Falls, N. Y.
Hoist Mfg. & Construction Co., Philadelphia, Pa.
Manning, Maxwell & Moore, New York.
Maris Bros., Philadelphia, Pa.
Niles Tool Works, New York.
Northern Engineering Wks., Detroit, Mich.
S. Obermayer Co., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Yale & Towne Mfg. Co., New York.

Crucibles.
McCullough-Dalzell Crucible Co., Pittsburg, Co.
S. Obermayer Co., Cincinnati, O.

Cupolas.
Northern Engineering Wks., Detroit, Mich.
S. Obermayer Co., Cincinnati, O.

Cutting-off Machines.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
W. P. Davis Mch. Co., Rochester, N. Y.
Espen-Lucas Mch. Wks., Philadelphia, Pa.
Fox Mch. Co., Grand Rapids, Mich.
Hurlbut-Rogers Mch. Co., So. Sudbury, Mass.
Merrell Mfg. Co., Toledo, O.
Pond Mch. Tool Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Standard Engineering Co., Ellwood City, Pa.
Stoever Fdry. & Mfg. Co., Myerstown, Pa.
Warner & Swasey Co., Cleveland, O.

Cut Meters.
Warner Instrument Co., Beloit, Wis.

Diamond Tools.
Dickinson, Thos. L., New York.
Steel Set Diamond Co., New York.

Dies. (See Taps and Dies.)

Die Heads, Self-Opening and Adjustable.
Geometric Tool Co., New Haven, Conn.
Modern Tool Co., Erie, Pa.

Die Stocks. (See Pipe Cutting Tools.)

Dowel Pins, Brass.
The Winkley Co., Hartford, Conn.

Drawing Tables.
Eugene Dietzgen Co., Chicago, Ill.
Fritz & Goeldel Mfg. Co., Grand Rapids, Mich.
Keuffel & Esser Co., New York.

Drawing Outfit.
Eugene Dietzgen Co., Chicago, Ill.
Keuffel & Esser Co., New York.

Drill Grinders.
Heald Mch. Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Wilmarth & Morman Co., Grand Rapids, Mich.

Drills, Rock.
Ingersoll-Sergeant Drill Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Rand Drill Co., New York.

Drills, Twist.
Boker, Hermann, & Co., New York and Chicago.
Cleveland Twist Drill Co., Cleveland, O.
Detroit Twist Drill Co., Detroit, Mich.
Kent, Edwin R., & Co., Chicago, Ill.
Morse Twist Drill & Mch. Co., New Bedford.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Syracuse Twist Drill Co., Syracuse, N. Y.
Three Rivers Tool Co., Three Rivers, Mich.
Whitman & Barnes Mfg. Co., Chicago, Ill.

For Alphabetical Index, see Page 20.

Classified Index to Advts. (Continued).

Drilling Machines.
American Tool Wks., Cincinnati, O.
Andrew, M. L., & Co., Cincinnati, O.
Baker Bros., Toledo, O.
B. F. Barnes Co., Rockford, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
H. G. Barr, Worcester, Mass.
Baush Mch. Tool Co., Springfield, Mass.
Betts Mch. Co., Wilmington, Del.
Bickford Drill & Tool Co., Cincinnati, O.
P. Blaisdell & Co., Worcester, Mass.
Burke Mchy. Co., Cleveland, O.
Cincinnati Mch. Tool Co., Cincinnati, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Dreses Mch. Tool Co., Cincinnati, O.
Duff Mch. Co., Lowell, Mass.
Dwight Slate Mch. Co., Hartford, Conn.
Foote, Burt & Co., Cleveland, O.
Fox Mch. Co., Grand Rapids, Mich.
Godell-Pratt Co., Greenfield, Mass.
Gould & Eberhardt, Newark, N. J.
Hamilton Mch. Tool Co., Hamilton, O.
Henry & Wright Mfg. Co., Hartford, Conn.
Knecht Bros. Co., Cincinnati, O.
Moline Tool Co., Moline, Ill.
Montgomery & Co., New York.
Mueller Mch. Tool Co., Cincinnati, O.
New Haven Mfg. Co., New Haven, Conn.
Pawling & Harnischfeger, Milwaukee, Wis.
Pond Mch. Tool Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
A. E. Quint, Hartford, Conn.
Francis Reed Co., Worcester, Mass.
Sibley Mch. Tool Co., So. Bend, Ind.
J. E. Snyder & Son, Worcester, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Whitcomb-Blaisdell Mch. Tool Co., Worcester.

Drilling Machines, Portable, Electrical Driven.
Clark, Jas., Jr., & Co., Louisville, Ky.
Hisey-Wolf Mch. Co., Cincinnati, O.
Stow Flexible Shaft Co., Philadelphia, Pa.
United States Elec. Tool Co., Cincinnati, O.

Dynamos.
Bissell, F., Co., Toledo, O.
Crocker-Wheeler Co., Ampere, N. J.
Cutler-Hammer Clutch Co., Milwaukee, Wis.
Eck Dynamo & Motor Wks., Belleville, N. J.
Electro-Dynamic Co., Bayonne, N. J.
Northern Electrical Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
B. F. Sturtevant Co., Hyde Park, Mass.
Western Tool and Mfg. Co., Springfield, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrotypers.
Lovejoy Co., New York.

Elevators.
Morse Elevator Wks., Philadelphia, Pa.

Emery Wheels.
Abrasive Material Co., Philadelphia, Pa.
Bridgeport Safety Emery Wheel Co., Bridgeport.
Corrugated Grinding Wheel Co., Philadelphia, Pa.
Hampden Corundum Wheel Co., Brightwood, Mass.
Norton Emery Wheel Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Sterling Emery Wheel Mfg. Co., Tiffin, O.
Vitrified Wheel Co., Westfield, Mass.

Emery Wheel Dresser.
Geo. H. Calder, Lancaster, Pa.
Desmond-Stephan Mfg. Co., Urbana, O.
T. L. Dickinson, New York..
International Specialty Co., Detroit, Mich.
Morton Mfg. Co., Muskegon Heights, Mich.
Standard Tool Co., Cleveland, O.
Steel Set Diamond Co., New York.

Engines.
American Blower Co., Detroit, Mich.
New Britain Mch. Co., New Britain, Conn.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
B. F. Sturtevant Co., Hyde Park, Mass.

Engines, Gas, Gasoline and Oil.
Brown-Cochran Co., Lorain, O.
Columbus Mch. Co., Columbus, O.
Foos Gas Engine Co., Springfield, O.
International Power Vehicle Co., Stamford, Conn.
Jacobson Mch. Mfg. Co., Warren, Pa.
Otto Gas Engine Wks., Philadelphia, Pa.

Engineering Appliances.
Crane Co., Chicago, Ill.

Exhaust Heads.
B. F. Sturtevant Co., Hyde Park, Mass.

Fans, Exhaust, Electric, Ventilating.
American Blower Co., Detroit, Mich.
B. F. Sturtevant Co., Hyde Park, Mass.

Fibre Calendering Machinery.
Lobdell Car Wheel Co., Wilmington, Del.

Files.
G. & H. Barnett Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Hayes File Co., Detroit, Mich.
Montgomery & Co., New York.
Nicholson File Co., Providence, R. I.
Reichhelm, E. P., & Co., New York.

Filing Machine.
Cochrane-Bly Co., Rochester, N. Y.

Fillet Cutters.
Milwaukee Foundry Supply Co., Milwaukee, Wis.

Fillet. (Leather.)
Butler, A. G., New York.
S. Obermayer Co., Cincinnati, O.

Flasks.
S. Obermayer Co., Cincinnati, O.

Flexible Shafts.
Coates Clipper Mfg. Co., Worcester, Mass.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.

Forges.
Billings & Spencer Co., Hartford, Conn.
B. F. Sturtevant Co., Hyde Park, Mass.

For Alphabetical Index, see Page 20.

Classified Index to Advts. (Continued)

Forgings.
Billings & Spencer Co., Hartford, Conn.
Clapp, E. D., Mfg. Co., Auburn, N. Y.
Erie Forge Co., Erie, Pa.
Hay-Budden Mfg. Co., Brooklyn, N. Y.
Phosphor Bronze Smelting Co., Philadelphia, Pa.

Forgings, Drop.
Billings & Spencer Co., Hartford, Conn.
Clapp, E. D., Mfg. Co., Auburn, N. Y.
Keystone Drop Forge Wks., Chester, Pa.
Phosphor Bronze Smelting Co., Philadelphia, Pa.
J. H. Williams & Co., Brooklyn, N. Y.

Forging Machines.
Scranton & Co., New Haven, Conn.

Foundry Facings, Brushes, Barrows, Shovels, Bellows and Blowers.
S. Obermayer Co., Cincinnati, O.
Paxson, J. W., & Co. Philadelphia, Pa.
J. D. Smith Fdry. Sup. Co., Cleveland, O.

Foundry Supplies.
Milwaukee Foundry Supply Co., Milwaukee, Wis.
S. Obermayer Co., Cincinnati, O.
Paxson, J. W., & Co. Philadelphia, Pa.
J. D. Smith Fdry. Sup. Co., Cleveland, O.

Friction Cone Pulleys.
G. F. Evans, Newton Center, Mass.

Fuel Economizers.
B. F. Sturtevant Co., Hyde Park, Mass.

Furnaces.
Burke Mchy. Co., Cleveland, O.

Furnaces, Electric.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Witteman, A. P., & Co., Philadelphia, Pa.

Gauges, Surface, etc.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Pratt & Whitney Co., Hartford, Conn.
John M. Rogers B., G. & D. Wks., Gloucester City, N. J.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
J. T. Slocomb Co., Providence, R. I.
E. G. Smith, Columbia, Pa.
L. S. Starrett Co., Athol, Mass.
J. Wyke & Co., Boston, Mass.

Gears.
Arthur Co., New York.
Hugo Bilgram, Philadelphia, Pa.
Boston Gear Wks., Boston, Mass.
H. W. Caldwell & Son Co., Chicago, Ill.
Cullman Wheel Co., Chicago, Ill.
Eberhardt Bros. Mch. Co., Newark, N. J..
Foote Bros. Gear & Mch. Co., Chicago, Ill.
Wm. Ganschow, Chicago, Ill.
Gleason Works, Rochester, N. Y.
Grant Gear Wks., Boston, Mass.
Jeffrey Mfg. Co., Columbus, O.
New Process Raw Hide Co., Syracuse, N. Y.
Philadelphia Gear Wks., Philadelphia, Pa.
Van Dorn & Dutton Co., Cleveland, O.

Gearing.
Earle Gear and Mch. Co., Philadelphia, Pa.
Eberhardt Bros. Mch. Co., Newark, N. J.
Morse Elevator Wks., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa

Gear-Cutting Machines.
Becker-Brainard Milling Mch. Co., Hyde Park.
F. H. Bultman & Co., Cleveland, O.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Pratt & Whitney Co., Hartford, Conn.
Van Dorn & Dutton Co., Cleveland, O.
D. E. Whiton Mch. Co., New London, Conn.

Gear Planer, Bevel.
Gleason Works, Rochester, N. Y.

Gear Shapers.
Fellows Gear Shaper Co., Springfield, Vt.

Graphite.
Jos. Dixon Crucible Co., Jersey City, N. J.
S. Obermayer Co., Cincinnati, O.

Grinders, Portable Electrical Driven.
Clark, Jas. Jr., & Co., Louisville, Ky.
Heald Mch. Co., Worcester, Mass.
Hisey-Wolf Mch. Co., Cincinnati, O.

Grinding Machinery.
B. F. Barnes Co., Rockford, Ill.
W. F. & John Barnes Co., Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Becker-Brainard M. Mch. Co., Hyde Park, Mass.
C. H. Besly & Co., Chicago, Ill.
Bridgeport Safety Emery Wheeel Co., Bridgeport.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Diamond Mch. Co., Providence, R. I.
Gould & Eberhardt, Newark, N. J.
Hisey-Wolf Mch. Co., Cincinnati, O.
Landis Tool Co., Waynesboro, Pa.
Modern Tool Co., Erie, Pa.
Montgomery & Co., New York.
Norton Emery Wheel Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Safety Emery Wheel Co., Springfield, O.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Whitney Mfg. Co., Hartford, Conn.

Hammers, Electric.
Northern Elec. Mfg. Co., Madison, Wis.

Hammers, Power, Steam and Drop.
Beaudry & Co., Philadelphia, Pa.
Bement, Miles & Co., Philadelphia, Pa.
Billings & Spencer Co., Hartford, Conn.
E. W. Bliss Co., Brooklyn, N. Y.
Bradley, C. C., & Son, Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Dienelt & Eisenhardt, Philadelphia, Pa.
Merrill Bros., Brooklyn, N. Y.
Pratt & Whitney Co., Hartford, Conn.

For Alphabetical Index, see Page 20.

Classified Index to Advts. (Continued).

Scranton & Co., New Haven, Conn.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.

Hardening and Tempering.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Coes Wrench Co., Worcester, Mass.

Heading, Upsetting and Forging Machines.
Acme Machinery Co., Cleveland, O.
Brown, H. B., Co., East Hampton, Conn.

Heating Machines.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Heating and Ventilating, Dust Collecting Systems.
American Blower Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, O.
B. F. Sturtevant Co., Hyde Park, Mass.

Heaters.
American Blower Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, O.
B. F. Sturtevant Co., Hyde Park, Mass.

Heaters and Purifiers.
Stewart Heater Co., Buffalo, N. Y.

Hoists.
Volney W. Mason & Co., Providence, R. I.
J. D. Smith Fdry. Sup. Co., Cleveland, O.

Hoists, Pneumatic.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Northern Engineering Co., Detroit, Mich.
Rand Drill Co., New York.
Stow Flexible Shaft Co., Philadelphia, Pa.

Hoists, Traveling and Electric.
Northern Engineering Co., Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.

Hydraulic Machinery.
Chambersburg Engineering Co., Chambersburg, Pa.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.

Hydraulic Tools.
Birdsboro Steel Fdry. & Mch. Co., Birdsboro, Pa.
Elmes, Chas. F., Eng'rg. Wks., Chicago, Ill.
Watson-Stillman Co., New York.

Index Center.
Stockbridge Mch. Co., Worcester, Mass.

Indicators.
L. S. Starrett Co., Athol, Mass.
R. Woodman Mfg. & Supply Co., Boston, Mass.

Injectors.
Jenkins Bros., New York.

Jacks.
Dienelt & Eisenhardt, Philadelphia, Pa.
Watson-Stillman Co., New York.

Key-Seaters.
Baker Bros., Toledo, O.
John T. Burr & Son, Brooklyn, N. Y.
W. P. Davis Mch. Co., Rochester, N. Y.
Mitts & Merrill, Saginaw, Mich.
Morton Mfg. Co., Muskegon Heights, Mich.
National Mch. Tool Co., Cincinnati, O.

Lathes.
American Tool Works Co., Cincinnati, O.
Baird Mchy. Co., Pittsburg, Pa.
B. F. Barnes Co., Rockford, Ill.
W. F. & J. Barnes Co., Rockford, Ill.
Bradford Machine Tool Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Mch. Tool Co., Box 3051, Bridgeport.
W. P. Davis Mch. Co., Rochester, N. Y.
Detrick & Harvey Mch. Co., Baltimore, Md.
Fay & Scott, Dexter, Me.
Flather & Co., Nashua, N. H.
Gisholt Mch. Co., Madison, Wis.
Goddard Mch. Co., Holyoke, Mass.
Gould & Eberhardt, Newark, N. J.
Greaves, Klusman & Co., Cincinnati, O.
Hamilton Mch. Tool Co., Hamilton, O.
Hendey Mch. Co., Torrington, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
R. K. Le Blond Mch. Tool Co., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
Montgomery & Co., New York.
New Haven Mfg. Co., New Haven, Conn.
Pond Mch. Tool Co., New York.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
F. E. Reed Co., Worcester, Mass.
Rivett Lathe Mfg. Co., Brighton, Mass.
Schumacher & Boye, Cincinnati, O.
Sebastian Lathe Co., Cincinnati, O.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Springfield Mch. Tool Co., Springfield, O.
Stark Tool Co., Waltham, Mass.
Von Wyck Mch. Tool Co., Cincinnati, O.
George D. Walcott & Son, Jackson, Mich.
Warner & Swasey Co., Cleveland, O.
Whitcomb-Blaisdell Mch. Tool Co., Worcester.

Lathe Attachments.
National Mch. Tool Co., Cincinnati, O.

Lathe and Planer Tools.
Armstrong Bros. Tool Co., Chicago, Ill.
Elgin Tool Wks., Elgin, Ill.
R. K. Le Blond Mch. Tool Co., Cincinnati, O.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Lockers.
Merritt & Co., Philadelphia, Pa.

Lubricants.
C. H. Besly & Co., Chicago, Ill.
Joseph Dixon Crucible Co., Jersey City, N. J.

Lubricating Compound.
Foote, Pierson & Co., New York.

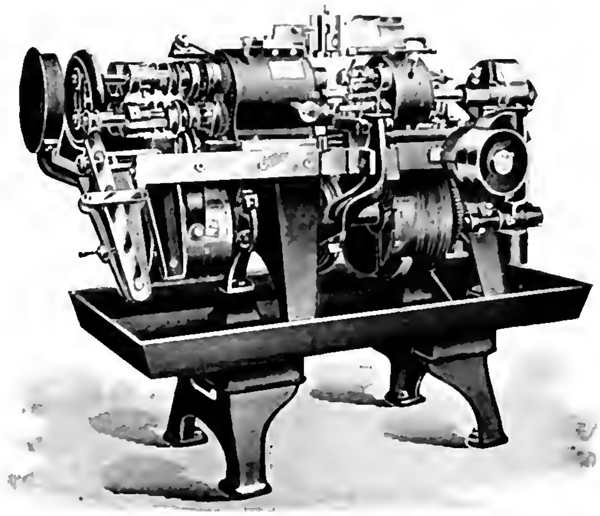
Machine Keys.
Morton Mfg. Co., Muskegon Heights, Mich.
Olney & Warrin, New York.
Standard Gauge Steel Co., Beaver Falls, Pa.

For Alphabetical Index, see Page 20.

Duplicate Parts are Interchangeably Made on the

ACME AUTOMATIC

The Wholesale Screw Machine.



Accuracy closer to the absolute can better be attained and maintained on the "Acme" with the aid of our *Patented Shaving Tool* than by any known process or method on any single spindle screw machine.

Rapidity of output is second only in importance. Every quarter turn of the cylinder represents a finished piece. With all tools (one set only) in operation simultaneously, and four bars of stock operated upon at the same time, an average "Acme" product of three to one over any single spindle automatic machine is a very conservative claim.

We Carry Complete Stock of Set and Cap Screws. Specials Made to Order. All particulars in catalog. Write for it to-day.

The National-Acme Manufacturing Co.,

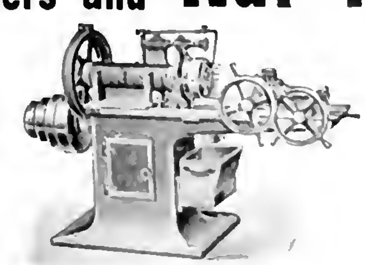
Cleveland, Ohio, U. S. A.

BRANCH OFFICES
New York, Boston, Chicago.

FOREIGN REPRESENTATIVES
Schuchardt & Schütte and Alfred H. Schütte

Bolt Threaders, Headers and Nut Tappers,

Write to us for anything you want in this line.



EUROPEAN AGENTS:
Schuchardt & Schütte, Cologne, Brussels, Berlin, Paris, Vienna and Stockholm.
C. W. Burton, Griffiths & Co., London.

THE ACME MACHINERY COMPANY, Cleveland, Ohio, U. S. A.
Office, 1125 Hamilton Street.

Classified Index to Advts. (Continued).

Machinery Dealers, Domestic.
George E. Alleck, New York.
Baush Mchy. & Supply Co., Springfield, Mass.
F. Bissell Co., Toledo, O.
J. J. McCabe, New York.
Motch & Merryweather Mchy. Co., Cleveland, O.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia.

Machinists' Small Tools.
Athol Mch. Co., Athol, Mass.
C. H. Besly & Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis, Frank M., & Co., Milwaukee, Wis.
Hammacher, Schlemmer & Co., New York.
Lutz Tool Mfg. Co., Springfield, O.
Montgomery & Co., New York.
Pratt & Whitney Co., Hartford, Conn.
John M. Rogers B., G. & D. Works, Gloucester City, N. J.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
J. T. Slocomb Co., Providence, R. I.
E. G. Smith, Columbia, Pa.
Standard Tool Co., Cleveland, O.
L. S. Starrett Co., Athol, Mass.
Syracuse Twist Drill Co., Syracuse, N. Y.
J. Wyke & Co., Boston, Mass.

Machinists' Supplies.
Baird Machinery Co., Pittsburg, Pa.
C. H. Besly & Co., Chicago, Ill.
Montgomery & Co., New York.
Pratt & Whitney Co., Hartford, Conn.

Mandrels.
Cleveland Twist Drill Co., Cleveland, O.
W. H. Nicholson & Co., Wilkesbarre, Pa.
Rich, Geo. R., Mfg. Co., Buchanan, Mich.
Standard Tool Co., Cleveland, O.
Western Tool and Mfg. Co., Springfield, O.

Mechanical Draft.
American Blower Co., Detroit, Mich.
B. F. Sturtevant Co., Hyde Park, Mass.

Metal.
Phosphor Bronze Smelting Co., Philadelphia, Pa.

Metal Polish.
Hoffman, George W., Indianapolis, Ind.

Milling Machines.
Adams Co., Dubuque, Ia.
Beaman & Smith Co., Providence, R. I.
Becker-Brainard Milling Mch. Co., Hyde Park.
Bement, Miles & Co., Philadelphia, Pa.
Carter & Hakes Mch. Co., Winsted, Conn.
Cincinnati Milling Mch. Co., Cincinnati, O.
Cleveland Auto. Mch. Co., Cleveland, O.
Dwight Slate Mch. Co., Hartford, Conn.
Fox Mch. Co., Grand Rapids, Mich.
Hendey Mch. Co., Torrington, Conn.
Ingersoll Milling Mch. Co., Rockford, Ill.
Kempsmith Mfg. Co., Milwaukee, Wis.
R. K. Le Blond Mch. Tool Co., Cincinnati, O.
Newton Mch. Tool Wks., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Sutton, C. E., Co., Toledo, O.
Waltham Watch Tool Co., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Milling Cutters.
Becker-Brainard Milling Mch. Co., Hyde Park.
Boston Gear Works, Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Holroyd & Co., Waterford, N. Y.
Kent, Edwin R., & Co., Chicago, Ill.
Morse Twist Drill & Mch. Co., New Bedford.
Pratt & Whitney Co., Hartford, Conn.
Reliance Mch. & Tool Co., Cleveland, O.
Standard Tool Co., Cleveland, O.
L. S. Starrett Co., Athol, Mass.
Union Twist Drill Co., Athol, Mass.

Milling Tools (Hollow Adjustable).
Geometric Tool Co., New Haven, Conn.

Molding Machines.
S. Obermayer Co., Cincinnati, O.

Motors.
Giant Motor Co., Newark, N. J.
Steffey Mfg. Co., Philadelphia, Pa.

Motors (Electric).
Bissell, F., Co., Toledo, O.
Crocker-Wheeler Co., Ampere, N. J.
Cutler-Hammer Clutch Co., Milwaukee, Wis.
Eck Dynamo & Motor Wks., Belleville, N. J.
Electro-Dynamic Co., Bayonne, N. J.
Guarantee Electric Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, O.
Northern Electrical Mfg. Co., Madison, Wis.
B. F. Sturtevant Co., Hyde Park, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Name Plates.
Turner Brass Works, Chicago, Ill.

Nozzles.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Nut Tappers.
Acme Mchy. Co., Cleveland, O.
National Mchy. Co., Tiffin, O.
Pratt & Whitney Co., Hartford, Conn.

Oil Cups.
Bay State Stamping Co., Worcester, Mass.
C. H. Besly & Co., Chicago, Ill.
W. M. & C. F. Tucker, Hartford, Conn.
Winkley Co., Hartford, Conn.

Oil-Hole Covers.
Bay State Stamping Co., Worcester, Mass.
W. M. & C. F. Tucker, Hartford, Conn.
Winkley Co., Hartford, Conn.

Oilless Bearings.
Arguto Oilless Bearing Co., Philadelphia, Pa.

Oil, Lubricating.
Dixon, Joseph, Crucible Co., Jersey City, N. J.

Packing.
Jenkins Bros., New York.
New York Belting and Packing Co., New York.

Patterns, Wood and Metal.
Balkwill Pattern Wks., Cleveland, O.
Moline Tool Co., Moline, Ill.
Penn Pattern Wks., Chester, Pa.

For Alphabetical Index, see Page 20.

Classified Index to Advts. (Continued).

Pattern Letters.
Butler, A. G., New York.

Patents.
Burnham, Royal E., Washington, D. C.
Dunn & Turk, New York.
Henry, F. G., Philadelphia, Pa.
Howson & Howson, Philadelphia, Pa.
Spear, Middleton, Donaldson & Spear, Washington, D. C.
Stevens, Milo B., & Co., Washington, D. C.
Whittlesey, Geo. P., Washington, D. C.

Pattern Shop Equipment.
Colburn Mch. Tool Co., Franklin, Pa.
Fox Machine Co., Grand Rapids, Mich.

Phosphorizers.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Pipe-Cutting and Threading Tools.
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Columbus Mch. Co., Columbus, O.
Curtis & Curtis Co., Bridgeport, Conn.
Eaton, Cole & Burnham Co., New York.
Hart Mfg. Co., Cleveland, O.
Merrell Mfg. Co., Toledo, O.
Oster Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
D. Saunders' Sons, Yonkers, N. Y.
Standard Engineering Co., Ellwood City, Pa.
Stoever Fdry. & Mfg. Co., Myerstown, Pa.
Trimont Mfg. Co., Roxbury, Mass.
Williams Tool Co., Erie Pa.

Planers.
Betts Mch. Co., Wilmington, Del.
P. Blaisdell & Co., Worcester, Mass.
Cincinnati Planer Co., Cincinnati, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Mark Flather Planer Co., Nashua, N. H.
Gleason Works, Rochester, N. Y.
G. A. Gray Co., Cincinnati, O.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Pond Mch. Tool Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Whitcomb-Blaisdell Mch. Tool Co., Worcester.
W. A. Wilson Mch. Co., Rochester, N. Y.

Plumbago.
S. Obermayer Co., Cincinnati, O.
Paxson, J. W., & Co., Philadelphia, Pa.

Pneumatic Tools.
General Pneu. Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, New York.
Rand Drill Co., New York.

Polishing Wheels.
Easton Polishing Supply Co., Easton, Pa.

Presses.
Billings & Spencer Co., Hartford, Conn.
E. W. Bliss Co., Brooklyn, N. Y.
Elmes, Chas. F., Eng'rg. Wks., Chicago, Ill.
Hamilton Mch. Tool Co., Hamilton, O.
Hoefer Mfg. Co., Freeport, Ill.
Lucas Mch. Tool Co., Cleveland, O.
Miner & Peck Mfg. Co., New Haven, Conn.
Springfield Mch. Tool Co., Springfield, O.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.

Pulley Blocks.
Yale & Towne Mfg. Co., New York.

Pulleys.
American Pulley Co., Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, O.
Ohio Pulley Co., Marion, O.
Philips Pressed Steel Pulley Wks., Philadelphia.
Poole Eng'r'g & Mch. Co., Baltimore, Md.
Saginaw Mfg. Co., Saginaw, Mich.
Wood's Sons, T. B., Chambersburg, Pa.

Pumps.
De Laval Steam Turbine Co., Trenton, N. J.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.

Punches and Dies.
Burke Mchy. Co., Cleveland, O.
Globe Mch. & Stamping Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
I. P. Richards, Providence, R. I.
Watson-Stillman Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Punching and Shearing Machinery.
Bertsch & Co., Cambridge City, Ind.
Birdsboro Steel Fdry. & Mch. Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn, N. Y.
Cincinnati Punch & Shear Co., Cincinnati, O.
Kirpa-Mason Mch. Co., Philadelphia, Pa.
Long & Allstatter Co., Hamilton, O.
New Doty Mfg. Co., Janesville, Wis.
Pond Mch. Tool Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Royersford Foundry & Mch. Co., Royersford, Pa
Sutton, C. E., Co., Toledo, O.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.

Pyrometer.
Englehard, Chas., New York.

Rapping Plates.
Milwaukee Fdy. Supply Co., Milwaukee, Wis.

Reamers.
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
John M. Rogers Boat, Gauge & Drill Works, Gloucester City, N. J.
Schellenbach & Radcliffe, Cincinnati, O.
Standard Tool Co., Cleveland, O.
Three Rivers Tool Co., Three Rivers, Mich.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Reamers, Pneumatic.
Stow Flexible Shaft Co., Philadelphia, Pa

For Alphabetical Index, see Page 20.

Classified Index to Advts. (Continued).

Riveters.
Chambersburg Engineering Co., Chambersburg.
Ingersoll-Sergeant Drill Co., New York.
Manning, Maxwell & Moore, New York.
Pedrick & Ayer Co., Plainfield, N. J.
Rand Drill Co., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.

Roller Bearings.
American Ball Co., Providence, R. I.
Auburn Ball Bearing Co., Rochester, N. Y.
Ball Bearing Co., Philadelphia, Pa.
Bantam Anti-Friction Co., Bantam, Conn.
Standard Roller Bearing Co., Philadelphia, Pa.

Saw Blades.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Goodell-Pratt Co., Greenfield, Mass.
Millers Falls Co., New York.
Montgomery & Co., New York.
West Haven Mfg. Co., New Haven, Conn.

Saws.
Birdsboro Steel Fdry. & Mch. Co., Birdsboro, Pa.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Espen-Lucas Mch. Wks., Philadelphia, Pa.
Goodell-Pratt Co., Greenfield, Mass.
Millers Falls Co., New York.
H. T. Story, Chicago, Ill.
Tabor Mfg. Co., Philadelphia, Pa.
West Haven Mfg. Co., New Haven, Conn.

Saws, Band.
Fox Mch. Co., Grand Rapids, Mich.

Schools.
Pratt Institute, Brooklyn, N. Y.
The International Corr. School, Scranton, Pa.

Screw Machines.
Asa S. Cook Co., Hartford, Conn.
Jas. D. Mattison, New York.
National-Acme Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Warner & Swasey Co., Cleveland, O.

Screws, Hollow Set.
Hammacher, Schlemmer & Co., New York.

Separators, Oil.
National Separator & Mch. Co., Concord, N. H.

Shaft Hangers.
Standard Pressed Steel Co., Philadelphia.
Wood's Sons, T. B., Chambersburg, Pa.

Shapers.
Cincinnati Shaper Co., Cincinnati, O.
Flather & Co., Nashua, N. H.
Mark Flather Planer Co., Nashua, N. H.
Fox Mch. Co., Grand Rapids, Mich.
Gould & Eberhardt, Newark, N. J.
Hendey Mch. Co., Torrington, Conn.
Kelly, R. A., Co., Xenia, O.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Smith & Mills, Cincinnati, O.
Springfield Mch. Tool Co., Springfield, O.
John Steptoe Shaper Co., Cincinnati, O.
Stockbridge Mch. Co., Worcester, Mass.
George D. Walcott & Son, Jackson, Mich.

Shop Pans.
Kilbourne & Jacobs Mfg. Co., Columbus, O.

Slotting Machines.
Betts Mch. Co., Wilmington, Del.
Dill, T. C., Mch. Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.

Special Machinery.
Blanchard Mch. Co., Boston, Mass.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
W. A. Wilson Mch. Co., Rochester, N. Y.

Speed Changing Device.
Evans, G. F., Newton Centre, Mass.
Reeves Pulley Co., Columbus, Ind.

Stamping, Sheet Metal.
Globe Mch. & Stamping Co., Cleveland, O.

Stamps, Letters and Figures.
Schwerdtle Stamp Co., Bridgeport, Conn.

Steel.
Frasse, P. A., & Co., New York.
Holroyd & Co., Waterford, N. Y.
Wm. Jessop & Sons, Ltd., New York.
Kent, Edwin R., & Co., Chicago, Ill.
Nash, Geo., & Co., New York.
Standard Pressed Steel Co., Philadelphia, Pa.
Witteman, A. P., & Co., Philadelphia, Pa.

Steel Castings and Forgings.
Birdsboro Steel Fdry. & Mch. Co., Birdsboro, Pa.
Hay-Budden Mfg. Co., Brooklyn, N. Y.
Wm Jessop & Sons, Ltd., New York.

Steel Rules.
Brown & Sharpe Mfg. Co., Providence, R. I.
Keuffel & Esser Co., New York.
Lufkin Rule Co., Saginaw, Mich.

Stoppers.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Taps and Dies.
C. H. Besly & Co., Chicago, Ill.
Butterfield & Co., Derby Line, Vt.
S. W. Card Mfg. Co., Mansfield, Mass.
J. M. Carpenter Tap & Die Co., Pawtucket, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Eaton, Cole & Burnham Co., New York.
Geometric Tool Co., New Haven, Conn.
Wm. Jessop & Sons, Ltd., New York.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Reed Mfg. Co., Erie, Pa.
Reliance Mch. & Tool Co., Cleveland, O.
Standard Tool Co., Cleveland, O.
Toledo Mch. & Tool Co., Toledo, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Wiley & Russell Mfg. Co., Greenfield, Mass.

For Alphabetical Index, see Page 20.

Classified Index to Advts. (Continued).

Tap Remover, Broken.
Atlas Mch. Co., Providence, R. I.

Tapping Attachments.
Beaman & Smith Co., Providence, R. I.
Cincinnati Mch. Tool Co., Cincinnati, O.
Modern Tool Co., Erie, Pa.

Tapping Machines.
Baker Bros., Toledo, O.
Burke Mchy Co., Cleveland, O.
Saunders', D., Sons, Yonkers, N. Y.

Thermit.
Goldschmidt Thermit Co., New York.

Thread Cutting Tool.
Rivet Dock Co., Brighton, Mass.

Thrust Bearings.
American Ball Co., Providence, R. I.
Ball Bearing Co., Philadelphia, Pa.
Standard Roller Bearing Co., Philadelphia, Pa.

Tools.
Hammacher, Schlemmer & Co., New York.
Montgomery & Co., New York.

Tool Holders.
Armstrong Bros., Tool Co., Chicago, Ill.
Beaman & Smith Co., Providence, R. I.
Elgin Tool Works, Elgin, Ill.
O. K. Tool Holder Co., Shelton, Conn.
Western Tool and Mfg. Co., Springfield, O.

Tool Racks.
New Britain Mch. Co., New Britain, Conn.

Tool Steel.
Frasse, P. A., & Co., New York.
Heller Bros., Newark, N. J.
Holroyd & Co., Waterford, N. Y.
Wm. Jessop & Sons, Ltd., New York.
Kent, Edwin H., & Co., Chicago, Ill.
Nash, Geo., & Co., New York.

Tote Boxes.
Kilbourne & Jacobs Mfg. Co., Columbus, O.

Tracks, Trolley and Overhead.
Coburn Trolley Track Mfg. Co., Holyoke, Mass.
Yale & Towne Mfg. Co., New York.

Trolleys.
Yale & Towne Mfg. Co., New York.

Transmission Machinery.
Jeffrey Mfg. Co., Columbus, O.
Link Belt Engineering Co., Philadelphia, Pa.
Reeves Pulley Co., Columbus, Ind.
Wood's Sons, T. B., Chambersburg, Pa.

Trimmers, Wood.
Fox Mch. Co., Grand Rapids, Mich.

Tubing.
Standard Welding Co., Cleveland, O.

Tumbling Barrels.
Globe Mch. & Stamping Co., Cleveland, O.

Turbines, Steam.
De Laval Steam Turbine Co., Trenton, N. J.

Turnbuckles.
Merrill Bros., Brooklyn, N. Y.

Turret Machinery.
Bardons & Oliver, Cleveland, O.
Bullard Mch. Tool Co., Box 3051, Bridgeport.
Fay & Scott, Dexter, Me.
Gisholt Mch. Co., Madison, Wis.
Hendey Mch. Co., Torrington, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Warner & Swasey Co., Cleveland, O.
Windsor Mch. Co., Windsor, Vt.

Universal Joints.
Bausch Mch. Tool Co., Springfield, Mass.
Boston Gear Wks., Boston, Mass.

Valves.
Crane Co., Chicago, Ill.
Hancock Inspirator Co., New York.
Jenkins Bros., New York.

Vises.
Armstrong Mfg. Co., Bridgeport, Conn.
Athol Mch. Co., Athol, Mass.
Atlas Mch. Co., Providence, R. I.
Carter & Hakes Mch. Co., Winsted, Conn.
Emmert Mfg. Co., Waynesboro, Pa.
Graham Mfg. Co., Providence, R. I.
Jacobson Mch. Mfg. Co., Warren, Pa.
Merrill Bros., Brooklyn, N. Y.
Montgomery & Co., New York.
Prentiss Vise Co., New York.
Reed Mfg. Co., Erie, Pa.
Wyman & Gordon, Worcester, Mass.

Welding.
Goldschmidt Thermit Co., New York.
Standard Welding Co., Cleveland, O.

Winches.
Yale & Towne Mfg. Co., New York.

Wire Nail and Washer Mchy.
Acme Mchy. Co., Cleveland, O.
National Mchy. Co., Tiffin, O.

Wire Working Machinery.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.

Wood Boring Machines, Pneumatic.
Rand Drill Co., New York.

Wood Working Machinery.
Fox Mch. Co., Grand Rapids, Mich.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Wrenches.
Armstrong Mfg. Co., Bridgeport, Conn.
Bemis & Call, H. & T., Co., Springfield, Mass.
Billings & Spencer Co., Hartford, Conn.
J. M. Carpenter Tap & Die Co., Pawtucket, R. I.
Coes Wrench Co., Worcester, Mass.
Eaton, Cole & Burnham Co., New York.
Keystone Drop Forge Wks., Chester, Pa.
Montgomery & Co., New York.
Reed Mfg. Co., Erie, Pa.
Trimont Mfg. Co., Roxbury, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.
J. H. Williams & Co., Brooklyn, N. Y.

For Alphabetical Index, see Page 20

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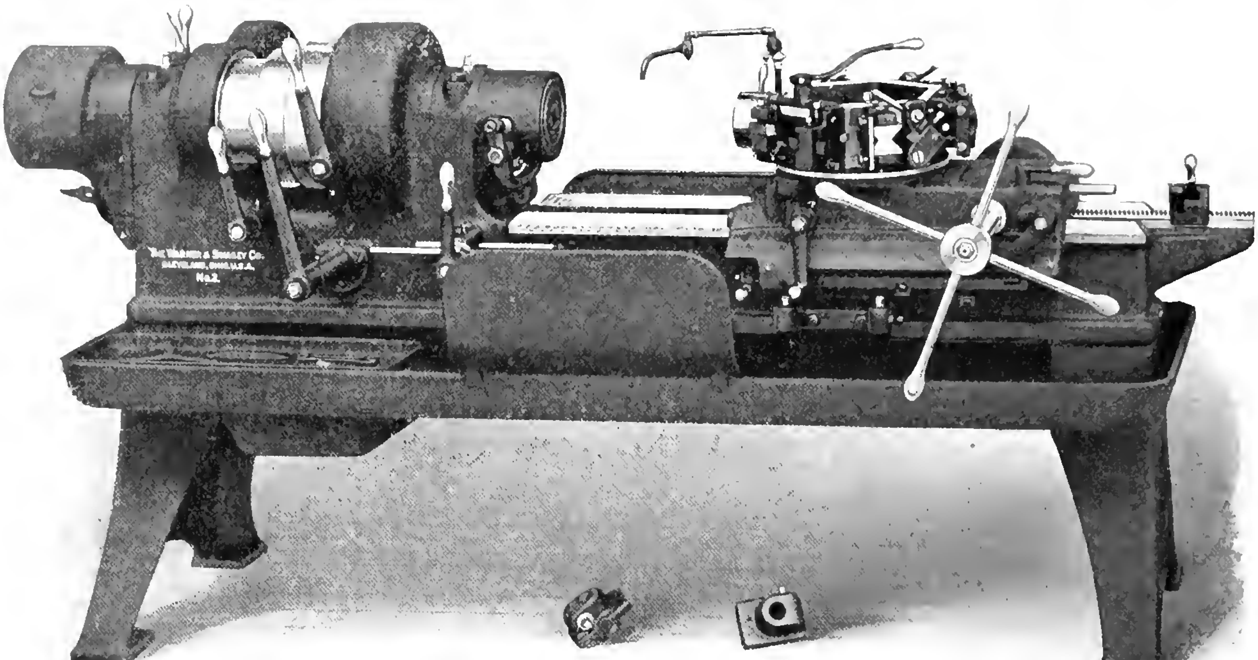

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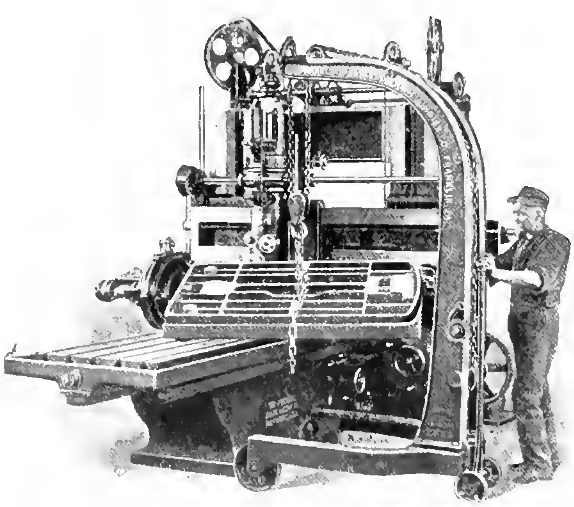

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STEEL BALLS
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BRONZE BALLS

"A" Grade Steel Balls for ordinary Ball Bearings
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"Hardware" Steel Balls for Hardware Specialties

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Largest Ball Makers in the world, also manufacturers of Ball Bearings, Roller Bearings, Automobile Bearings, etc.

A Pattern Maker without a Fox Wood Trimmer
within arm's reach

is only half the man he would be with one there.

A small bench machine should be devoted to every individual pattern maker's use. It will then be sharp and convenient, just as his planes and chisels are.

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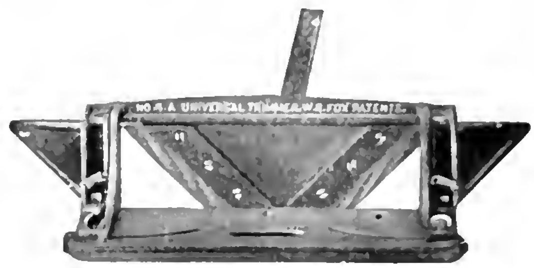

FOX MACHINE COMPANY
Complete Pattern Shop Equipment,
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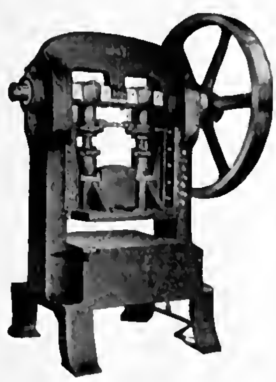

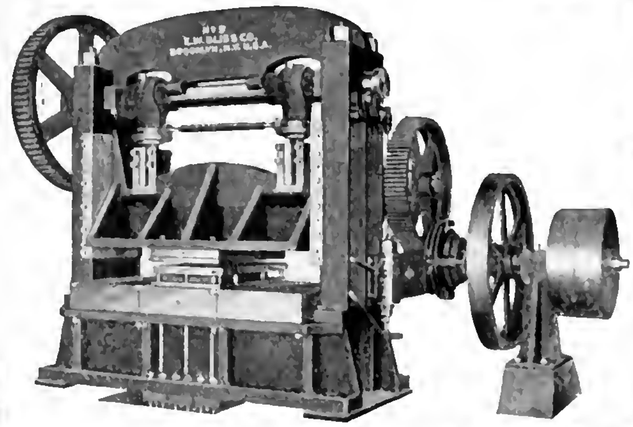

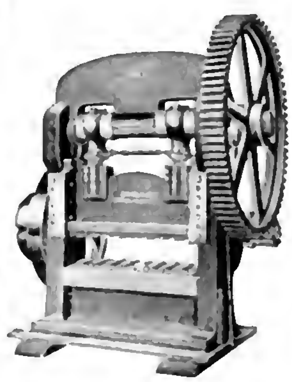

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AGENTS FOR CHICAGO AND VICINITY

Cone Pulley Design

An old problem with draftsmen and one that has been a favorite topic with textbook writers, is that of the design of cone pulleys. It was supposed long ago that the last word had been said on this subject. We have an article for the September number by a Professor at the University of Illinois, which gives an extremely simple as well as accurate and graphic solution. In looking through German literature he accidentally ran across this solution, which apparently has not been known in America; and he explains its application by using illustrative examples so that draftsmen can apply it. By its aid a pair of cone pulleys can be designed in ten minutes, that, by the usual analytical methods, would require several hours to proportion.

Spiral Gear Problems

Another practical article deals with a subject that a great deal has been written upon, and like the previous one, commends itself to the reader, because it simplifies the problem for the benefit of the student and designer. This article treats of spiral gears, and is by Professor E. H. Fish, of the Worcester Polytechnic Institute. The course at Worcester is extremely practical, treating largely of the shop end of engineering, and they have developed a system for the solution of spiral gear problems that is direct, simple and practical, and which forms the subject of the article in question.

Charts for Proportioning the parts of Machines

Several charts will be published in the body of the paper, some of them covering full pages, to assist the draftsman in proportioning the parts of machines and saving him laborious calculations. One of these is an elaborate diagram giving safe dimensions for thick cylinders to withstand high pressures. Another is upon the relative torsional strength and weight of solid and hollow shafts. This latter is an unusually complete and comprehensive table. Still another chart, which is the most complete of its kind that we have seen, is for the purpose of calculating the time for machine work at different feeds and speeds. Numerous smaller diagrams will appear, one upon proportions for machine handles, and others of equal practical value.

Short Articles

BEVEL GEAR CHARTS. By George J. Porter, Syracuse, New York. Gives simple rules for calculating all the required elements for bevel gears when mated at any angle.

GROUPING MACHINERY DATA SHEETS. By K. B. Illustrates a method of grouping data sheets in convenient form so as to have subjects of like nature together.

KINKS FOR DRAFTSMEN. By E. W. Beardsley, Waterbury, Conn. Gives some hints for instrument repairs, making celluloid templets, special scales, etc.

INSTRUCTIONS FOR DRAFTSMEN. By E. W. Beardsley, Waterbury, Conn. Gives some practical hints which are the result of years of experience in the drawing room, which should be particularly valuable to young draftsmen.

TABLE FOR SETTING PROPORTIONAL DIVIDERS. By Herman Jonson, New York.

CHECKING DRAWINGS. By Robert Grimshaw. This article takes up step by step the features of drawings which should be carefully verified.

MACHINERY'S DRAFTSMEN'S NUMBER

SEPTEMBER, 1905 SINGLE COPIES 20 CENTS

THE INDUSTRIAL PRESS, PUBLISHERS, 66-70 WEST BROADWAY, NEW YORK

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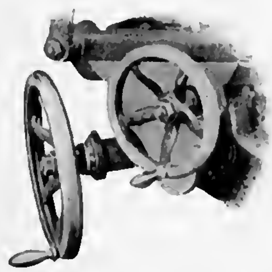
1 All wearing surfaces and bearings proportioned to insure rigidity and maintenance of alignment.

Spindle bearings inside of frame—no overhang. Uprights supporting bearings, solid metal.

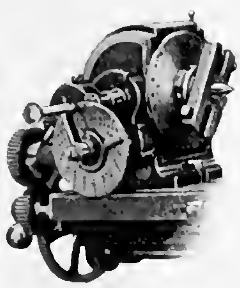
2 The overhanging arm is a solid steel bar simply and efficiently clamped at both bearings by one lever.



3 The Feed Tripping Mechanism is of the double plunger type and unusually sensitive.

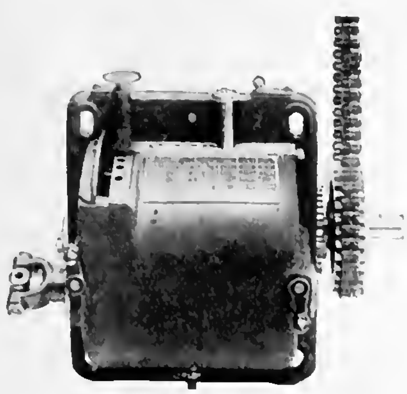
4 Fixed Hand Wheels are provided for the cross and vertical feed shafts.

5 The Knee Screw is telescopic and does not extend below the base of the machine.



6 The Spiral Head is exceptionally rigid and fitted for either Plain or Differential Indexing.

7 The Table Feed Screw is not splined. Drive from auxiliary shaft which carries clutch gears.



8 The Variable Feeding Mechanism is driven by chain direct from spindle to gear case, no intermediate gearing. Changes made by adjusting Index Slide and Levers.

Pamphlet giving detailed description mailed free to any address.

400 Milling Machines in operation throughout the plant. Our experience may be of service to you.

a recess provided to receive it, should this be desirable, as is frequently the case in applying it to small trolley hoist work, etc. Or it may be rotated within the case so as to permit it being placed in any desired position, as on the sides or top of crane cab. It may also be arranged for rope operation from the floor, in which case a centering spring is provided. Types B and C may be provided with bell crank and link to permit of installation at the back of the cab and operation by levers from the front. Resistance is provided which will give a speed reduction of 50 per cent under the average load conditions on the crane. All contacts are of hard-drawn copper, and may be readily renewed from the front of the controller without disturbing any connections at the rear. All brushes are of drop-forged copper, easily renewable and interchangeable, and are so shaped as to ride over the contacts and give a good working contact even when the contacts have become considerably roughened. A large number of contacts is used, providing for gradual speed changes, and practically eliminating all sparking between segments. The controllers are designed to occupy the minimum space consistent with the duty they are required to perform, and their arrangement is such that the operator's view is practically unobstructed. Arrangements for slow speed control may be obtained in types B and C. This feature has not been fully developed as yet, but bulletins will shortly be issued covering same.

MISCELLANEOUS TOOLS AND APPLIANCES.

Keuffel & Esser, 127 Fulton St., New York, have brought out a tool which they call the "Paragon Drafting Instrument." It is made of German silver, and is intended to combine the functions of the scales, triangles, protractor, etc., with which the draftsman's board is generally covered. It is mounted and slides on the T-square or straight-edge.

A chain hoist made on the differential gear principle is being manufactured by the Franklin-Moore Company, Winsted, Conn. The mechanism of this hoist is so arranged that by throwing a pawl out from a ratchet wheel, the hook may be given a rapid movement, such as is needed in bringing it down to the work or in taking up slack in the chain. Otherwise, the hoist is operated in the usual manner.

The Reeves variable-speed drive has lately been improved in one or two particulars. The thrust for the hub of the disks is now made in the form of a roller bearing, the rollers being very short and set in pockets in a split brass cage in alternate groups of two and three, so that the wear may be evenly distributed over the face of the collars. On the larger sizes, the disks, instead of being driven by a key in the shaft as formerly, slide in and out on three ground steel pins, mounted on a collar between them. The motion is thus transferred from the shaft to the disks by these pins. This drive is built by the Reeves Pulley Co., Columbus, Ind.

* * *

A coiled-spring friction clutch is manufactured by the Double Friction Coil Clutch Co., Chicago, Ill. The advantages claimed for the clutch are small space occupied and an extremely powerful drive, together with a gradual application of the driving force when the clutch is put into operation. This latter is the distinctive feature of the clutch which makes it essentially different from other friction-coil clutches. The clutch operates by coiling a spiral spring tightly about an inner drum. There is an auxiliary friction arrangement, however, consisting of a disc on the periphery of which is a lug that comes in contact with a pin projecting from the end of the coil spring. When the clutch is disconnected this disc turns freely on the shaft and offers no resistance tending to coil the spring; but when the clutch mechanism is thrown in this disc is held by frictional contact between two surfaces which are brought together with a greater or less degree of force, according to the way in which the clutch is adjusted. This disc, therefore, gradually tightens the coil on its drum instead of acting suddenly, as would be the case if positive contact were made with the coil instead of using the intermittent friction arrangement.

FRESH FROM THE PRESS.

HENDRICKS' COMMERCIAL REGISTER OF THE UNITED STATES. Published by the S. E. Hendricks Co., 76 Elm Street, New York City. 1,275 pages, price $7.00.

This is the fourteenth annual edition of the well-known business directory published by this company. It contains over 350,000 names, addresses and business classifications, with lists of manufacturers and dealers, chiefly in the architectural, mechanical, engineering, contracting, electrical, railroad, iron, steel, mining, mill, and quarrying industries. The directory is carefully revised each year and brought up to date as completely as possible.

THE TEXTILE WORLD OFFICIAL DIRECTORY OF THE TEXTILE INDUSTRIES OF THE UNITED STATES AND CANADA. Published by the Lord & Nagle Co., 299 Devonshire Street, Boston, Mass. Price $2.00. 462 pages with 22 maps, showing location of towns having textile industries.

The directory is divided into five parts, consisting of textile manufacturers, yarn trade industries, commission and order mills and dealers in raw material and agents and buyers. This new edition contains the names of 624 textile establishments which did not appear last year. The immensity of the textile industries is shown by the summary of machinery statistics, from which we learn that there are 25,500,000 cotton spindles in this country and Canada; over 580,000 cotton looms, 88,000 woolen looms, 68,000 silk looms, and 100,000 knitting machines.

AN INVESTIGATION OF ROTATIONS PRODUCED BY CURRENTS FROM A SINGLE-PHASE ALTERNATOR, by Arthur Curtis Scott. Published by the University of Wisconsin, Madison, Wis., being Bulletin No. 102. 162 pages 6½ x 9¼ inches, illustrated by 96 cuts. Price 50 cents.

This valuable pamphlet is a thesis submitted for degree of Ph.D., University of Wisconsin, 1902. The author endeavors to give a comprehensive history and survey of the development of the single-phase alternator. The chronology begins Christmas Day, 1821, which date marks the primary production of magnetic rotation by Michael Farraday, who then first obtained the revolution of the magnet around an electric current. The author says in his prefatory note that the subject of electric engineering has received most extraordinary attention during the last decade and particularly is this true with respect to the branch of alternating currents. But discoveries and investigations have followed one another so rapidly that little attention has been given to the history of development. The pamphlet under review appears to be a very conscientious effort to present the correlation of experimental data and theories concerning the development of single-phased rotations. It is one that any advanced electrician should be able to read with profit.

A particularly attractive feature of the *Century* for August is a complete story by Rudyard Kipling entitled "An Habitation Enforced." This is written in the great story-teller's happiest vein, and is all the more welcome in that it is the first work from Mr. Kipling's pen to appear in any American magazine for nearly a year. The seasonable sports, rowing and automobiling, are exploited in Ralph D. Paine's "The Spirit of School and College Sport," and "Alpine Climbing in Automobiles," by Sterling Heilig; both these articles breathe that charm which can only be gained by personal interest and experience. The concluding chapter of Mr. Gibson's "The Associated Press" series and a second installment of "The Electric Railway" appear in this number, together with the usual timely sketches, fiction and verse, and the issue is further enriched by color drawings by Ivanowski and Howard Chandler Christy.

NEW TRADE LITERATURE.

E. W. Bliss Co., Brooklyn, N. Y., describing the minting machinery made by this company. There are many handsome illustrations.

Akron Belting Co., Akron, Ohio. Catalogue of leather, rubber and cotton belting, belt dressing, oil filters, hose and general supplies.

Oswego Tool Co., Oswego, N. Y. Illustrated price list of wrenches, tube expanders, lathe dogs, vises, pipe cutting tools, punches, ratchets, etc.

Browning Engineering Co., Cleveland, Ohio. Bulletin No. 19 of the Browning locomotive cranes, which are made in a great variety of styles and sizes for handling all kinds of material.

Kisinger-Ison Co., Cincinnati, Ohio. Illustrated circular of the Sterling friction clutch explaining its construction and containing price list of the different sizes.

American Blower Co., Detroit, Mich. Catalogue No. 180 of exhaust fans. This illustrates the various styles and applications of the A. B. C. series of blowers and fans made by this company.

Electro Dynamic Co., Bayonne, N. J. Circular No. 14 describing the interpole variable speed motor with diagrams showing efficiency and speed curves, dimensions of motors, etc.

The Bethlehem Steel Co. are at work on three crank shafts which will weigh when finished 86,600 pounds each. They are turned out of solid steel ignots and are intended for three Snow gas engines.

At the last annual meeting of the Woodward & Powell Planer Co., E. M. Woodward was elected president and treasurer, A. M. Powell, vice-president and superintendent, and J. W. Robinson secretary.

Chicago Flexible Shaft Co., Chicago, Ill. A new catalogue, describing their full line of gas furnaces, flexible shafts, etc., is now ready for distribution.

Ellis W. Morse & Co., 112 Court Street, Binghamton, N. Y., have recently moved into their new five-story block at 81 State Street. The building is well equipped, each floor being occupied by a special department.

The Dayton Hydraulic Machinery Co., R. E. Spencer Geare, sales manager, have opened a New York branch office at 133 Liberty Street. They will carry a line of Brooks' centrifugal pumps, of which they are exclusive manufacturers.

Mr. Harry V. Croll, M. E., for the past eight years with the E. P. Allis Company, and their successors, Allis-Chalmers Co., of Chicago, has resigned and accepted a position with the Wellman-Seaver-Morgan Co., Cleveland, O.

Link-Belt Engineering Co., Philadelphia, Pa. Catalogue devoted to the Renold roller chain, which explains the advantages of this chain for power transmission and shows how to shorten or increase the length of the chain by removing or adding links.

Lutz Tool Mfg. Co., Springfield, Ohio. Catalogue of surfacing tools consisting of file handles of different designs and a variety of scrapers and scraper holders. These scrapers are made with inserted blades, fixed or adjustable, as desired.

Diamond Saw and Stamping Works, Buffalo, N. Y. Catalogue of Sterling hack saw blades and frames, which are made in various styles and sizes by this company for the different classes of work upon which hack saws can be advantageously employed.

Newton Machine Tool Works, Philadelphia, Pa. Catalogue No. 41 of rotary planing machines. These are made in sizes from 26 inches up to 96 inches diameter of cutter head and with vertical, horizontal and duplex spindles; also of special construction for different classes of work.

The Wellman-Seaver-Morgan Co., Cleveland, O., have appointed Mr. W. A. Stadelman, formerly Eastern agent of their company, general sales agent, with headquarters at Cleveland, O. They have also appointed Mr. Fred Stadelman assistant manager of the New York office, No. 42 Broadway.

Hisey-Wolf Co., Cincinnati, Ohio. Illustrated catalogue of portable, electrical tools, consisting of self-contained portable grinders and drills, adapted to be mounted at the place where the work is to be done, the former being suitable for use on the lathe, milling machine or planer. This company has also brought out a series of tools adapted for the alternating current.

Northern Engineering Works, Detroit, Mich. Catalogue No. 20 of cranes. Many standard and special designs of traveling cranes are illustrated in this catalogue showing locations where they have been installed, and there are also listed a variety of trolley hoists, pneumatic hoists, pillar, job, locomotive and other types of cranes. The catalogue contains over one hundred half-tone illustrations.

Otto Gas Engine Works, Thirty-third and Walnut Streets, Philadelphia, Pa., have issued an attractive booklet entitled, "Some Reasons Why." The nature of the contents can be guessed from the title, but the attractiveness of the booklet can only be appreciated by looking through its pages. It is an exceedingly neat presentation of the claims of the Otto engine.

Chicago Flexible Shaft Co., LaSalle Avenue and Ontario Street, Chicago, Ill. Illustrated catalogue of Stewart's gas blast furnace and flexible shafts. It describes a few of the purposes for which these furnaces are adapted, pointing out the advantages of a uniform heat treatment for steel. The flexible shafts and various tools made by this company to be operated by this form of transmission are also described.

MANUFACTURERS' NOTES.

Hill-Standard Mfg. Co., Anderson, Ind., manufacturers of tool holders, dogs and machine vises, are now located in their new factory which is in complete running operation.

The Union Twist Drill Co., Athol, Mass, announce that Mr. Walter A. Darling, formerly connected with the cutter department of the Brown & Sharpe Mfg. Co., has accepted the position of manager of their New York store.

G. D. Michell, formerly of the United Shoe Machinery Co. and for a long time with the Jones & Lamson Machine Co., has now become associated with the Warner & Swasey Co. of Cleveland, Ohio, in the capacity of Western representative.

The S. Obermayer Co., manufacturers of foundry facings and supplies, of Cincinnati, O., have opened an office at 120 Liberty Street, New York. Mr. Edgar G. Seeman, who has represented the company at Pittsburg for many years past, has charge of the New York office.

United States Electric Tool Co., William A. McCallum, President, Cincinnati, Ohio, have recently removed to a new factory at Eighth St. Viaduct and C. H. & D. Ry., where they have improved facilities and ample room to meet the increasing requirements of their business.

The business of the Royersford Foundry and Machine Co., Royersford, Pa., is constantly increasing. The works in all the departments are running full and the sales of Royersford punch and shearing machines so far this season has been larger than ever before in the history of their manufacturing.

The Whitcomb-Blaisdell Machine Tool Co. has been formed by the union of the Whitcomb Mfg. Co., the P. Blaisdell & Co. and the Whitcomb Foundry Co. Their main offices are located at 134 Gold Street, Worcester, Mass. The business will be conducted along the same lines as were heretofore followed by the individual firms.

Mr. W. E. Farrell, for many years manager of the Birdsboro Steel Foundry and Machine Co., has severed his connection with that company to accept the vice-presidency of M. H. Treadwell & Co., Myrestown and Lebanon, Pa. Mr. Farrell will be located at Lebanon, having entire charge of the plant at that place.

The Eaton, Cole & Burnham Co., Bridgeport, Conn, have recently erected two enormous signs over their plants, one of which is over 1,100 feet long, and another which is on a large water tank 130 feet in the air. These signs are so unusual in size and so conspicuously located as to quite generally attract the attention of travelers between Boston and New York.

Wilcox Mfg. Co., Aurora, Ill., have increased their capacity in the overhead trolley track department and installed heavier machinery for the manufacture of all types of cranes. Mr. C. F. Blake, who is a well-known mechanical engineer, having devoted many years to hoisting machinery, and who is also a frequent contributer to MACHINERY, has been placed in charge of the new department. The Wilcox Co. is now in a position to make bids on hoisting equipment of every kind.

The Crocker-Wheeler Co., Ampere, N. J., have held their annual election of officers for the ensuing year. They are as follows: President, Schuyler Skaats Wheeler; vice-president and chief engineer, Gano S. Dunn; treasurer, W. L. Brownell; assistant treasurer, G. W. Bower; directors, Prof. Francis B. Crocker of Columbia University, Dr. Wheeler, Messrs. Dunn and Doremus, A. Foster Higgins, Herbert Noble, Thomas Ewing, Jr., F. L. Eldridge and C. A. Spofford. The regular quarterly dividend of 1½ per cent. has been declared and the affairs of the company are in a flourishing condition.

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Submit specifications and let us quote and send samples.

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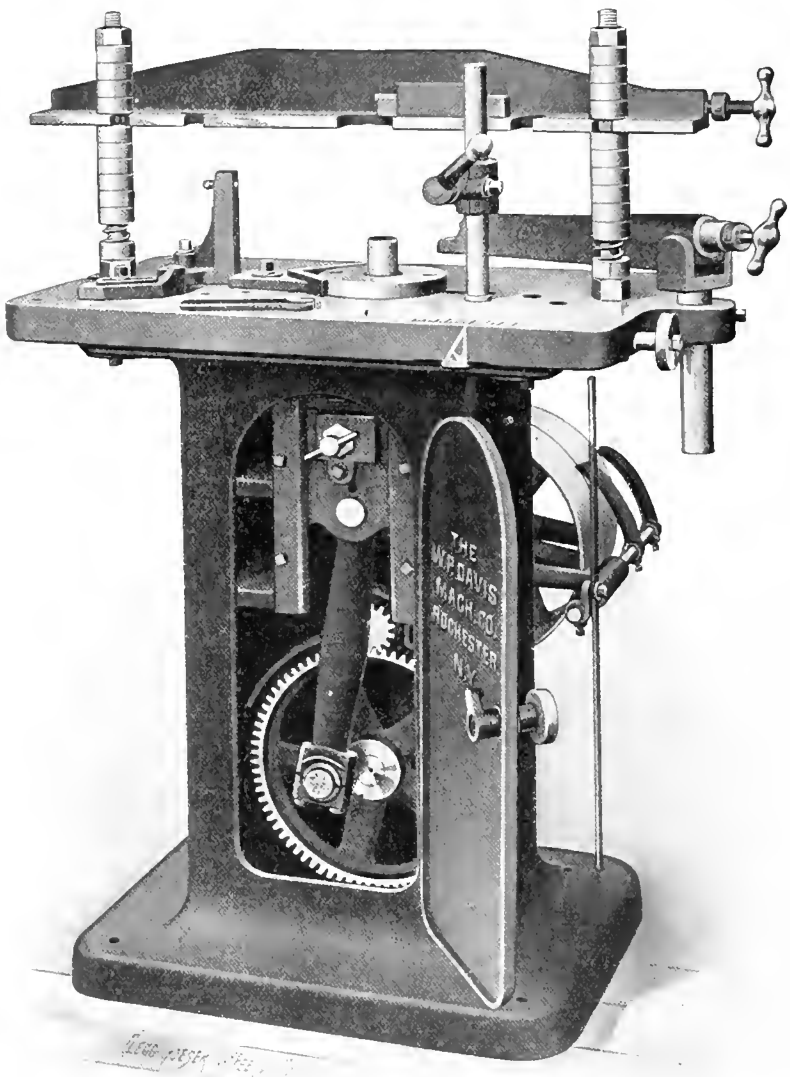

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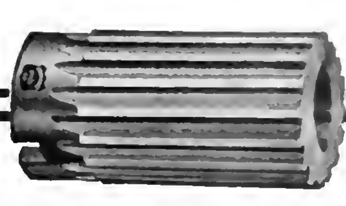

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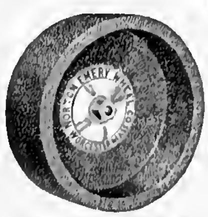

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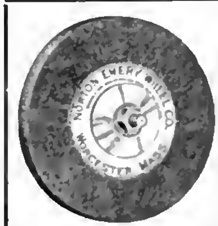

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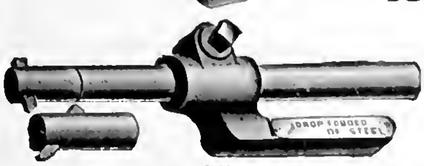

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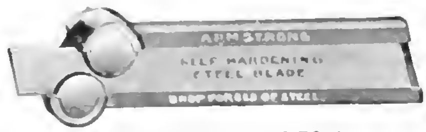

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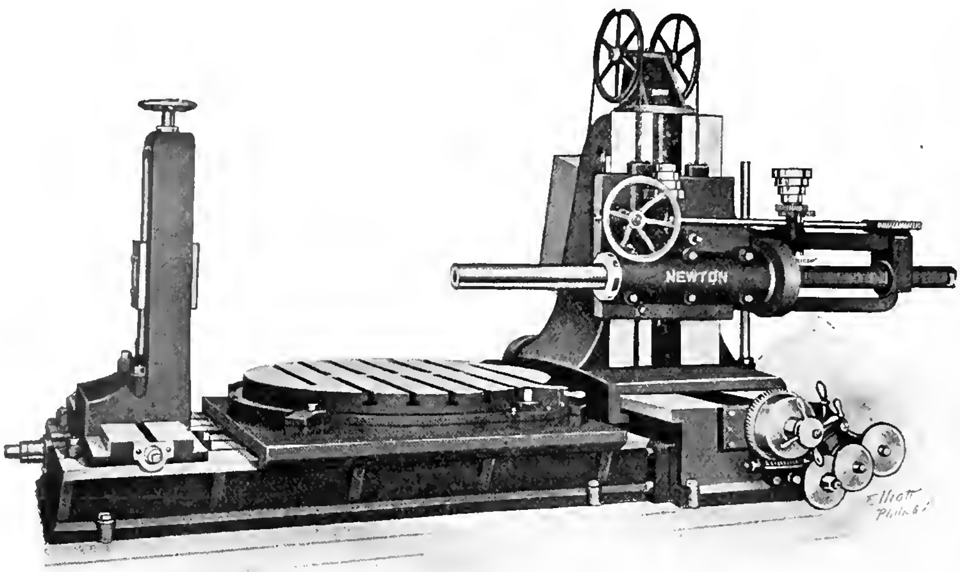

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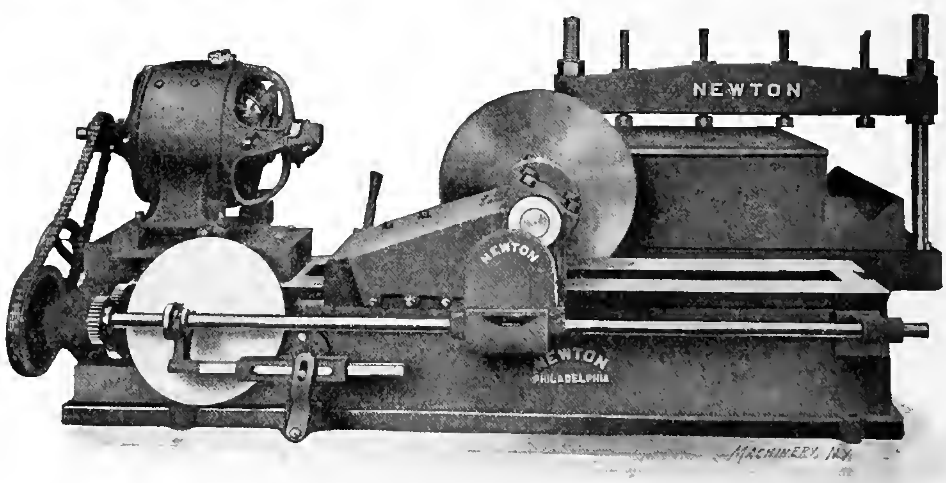

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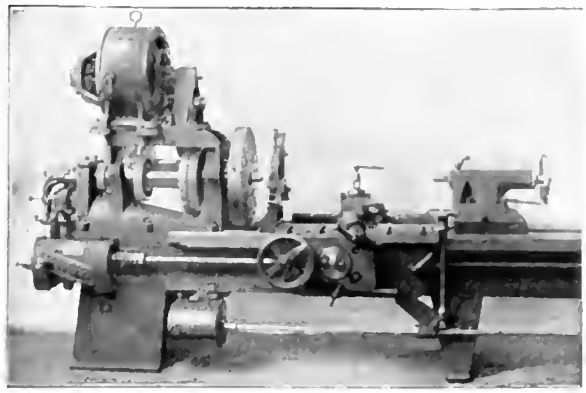

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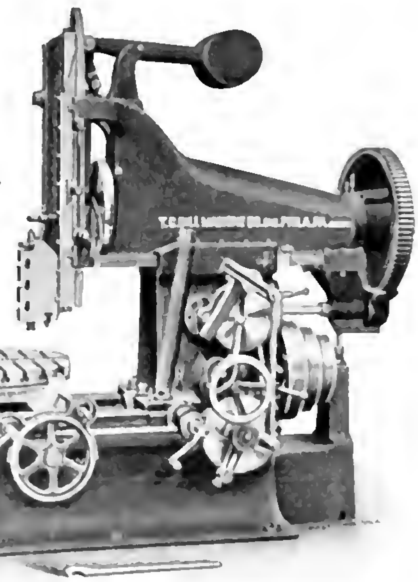

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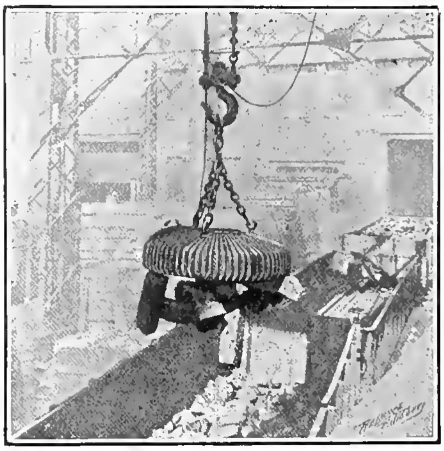

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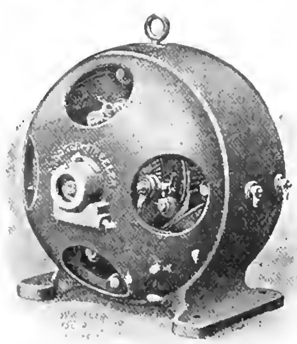

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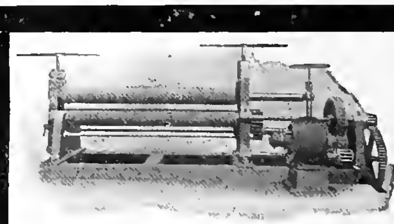

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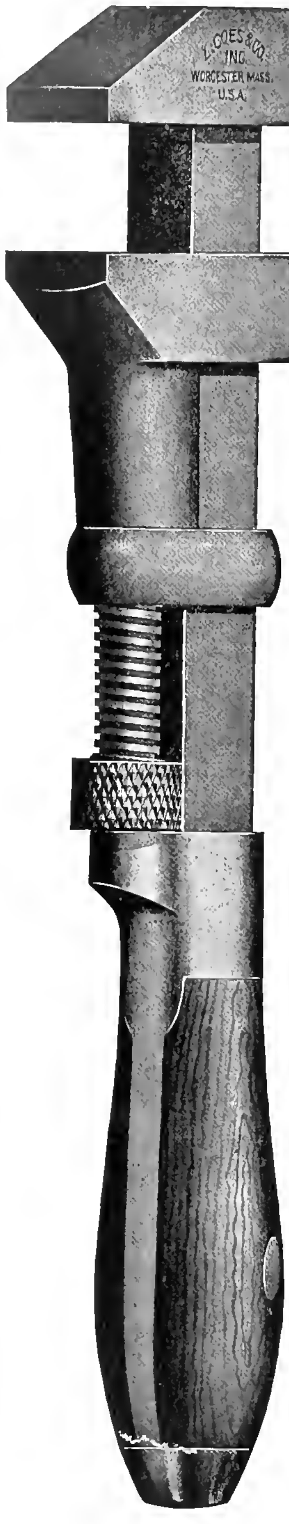

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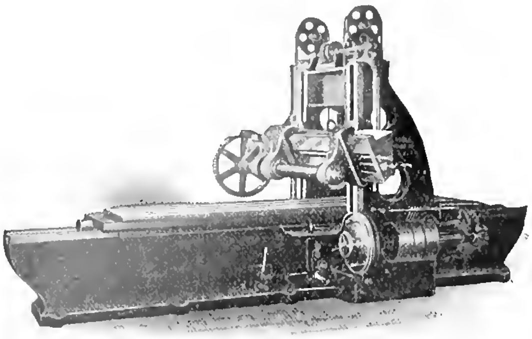

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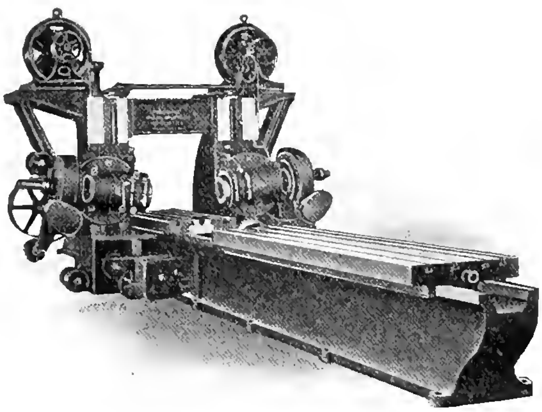

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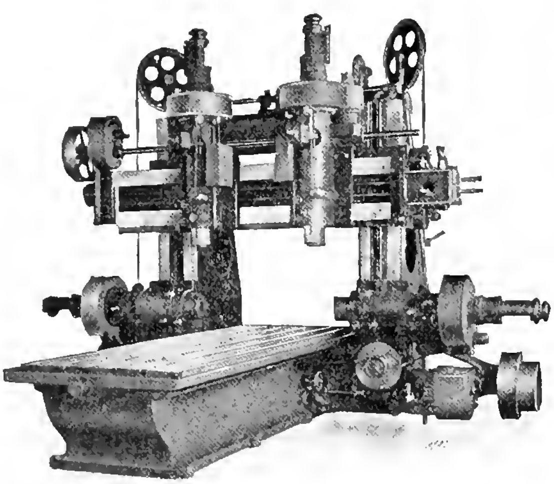

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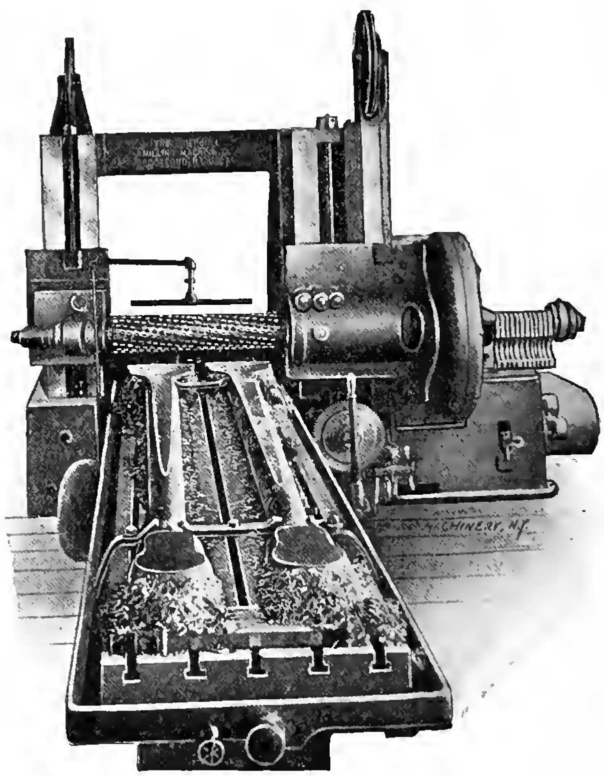

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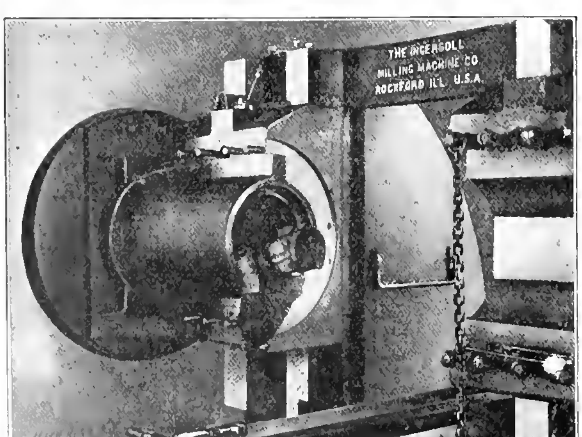

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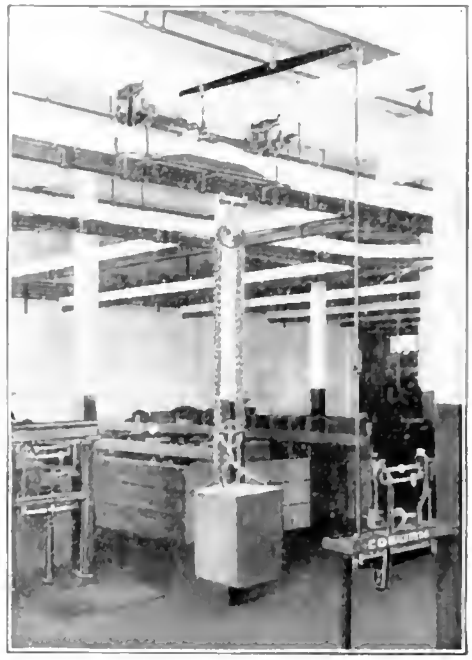

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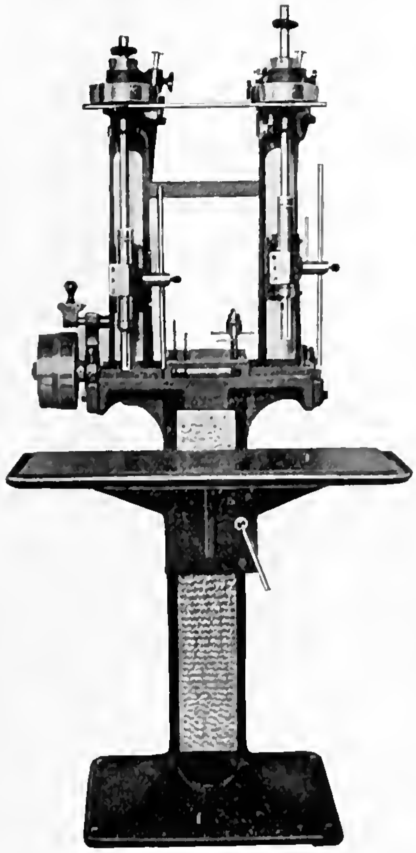

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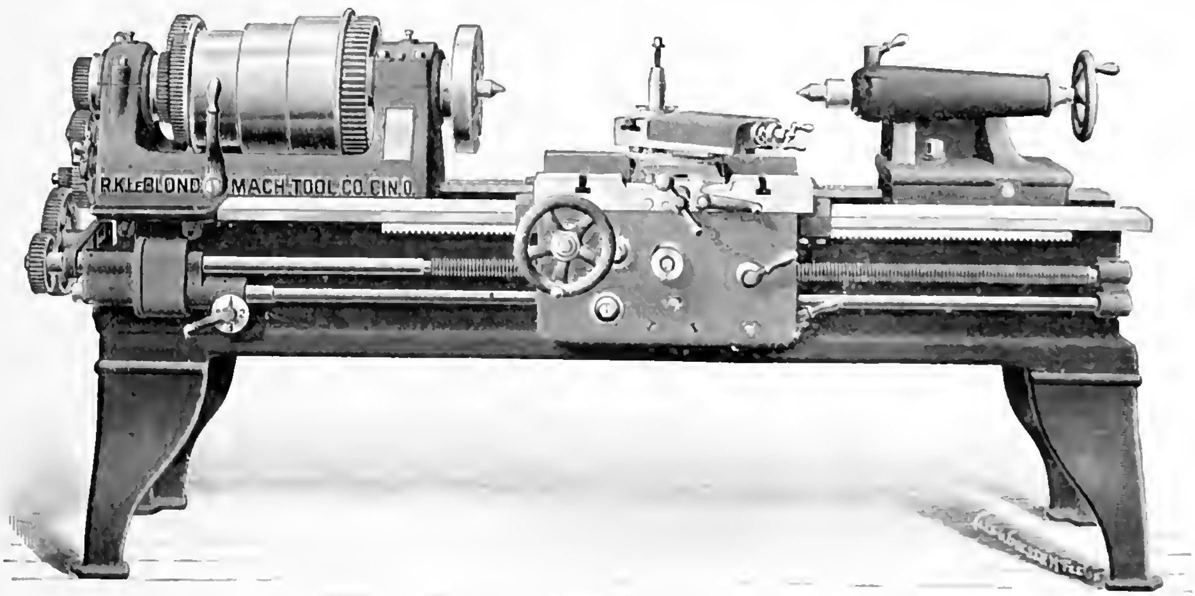

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MACHINERY.

August, 1905.

THE BURSTING STRENGTH OF WOODEN PULLEYS.

C. H. BENJAMIN.

C. H. Benjamin.

During the winter of 1902-3 a series of experiments was carried on in the laboratories of the Case School, Cleveland, Ohio, by Mr. E. G. Schick, a junior student, to determine the bursting speeds of various types of wooden pulleys such as are used on shafting. At the time it was expected that these experiments would be supplemented by others, but the pressure of other work prevented this. It seems best, therefore, to publish such results as we have, pending further tests.

Eight pulleys of three different makes were tested, Nos. 1 and 2 being made by one firm, Nos. 3, 4 and 8 by another, while Nos. 5, 6 and 7 were the product of a third factory.

The pulleys were four inches in width of rim and all were two feet in diameter, except No. 7, which had a diameter of twenty inches. The testing apparatus was the same as that used so extensively in bursting small flywheels and is shown in Fig. 1 with pulley No. 1 in position.

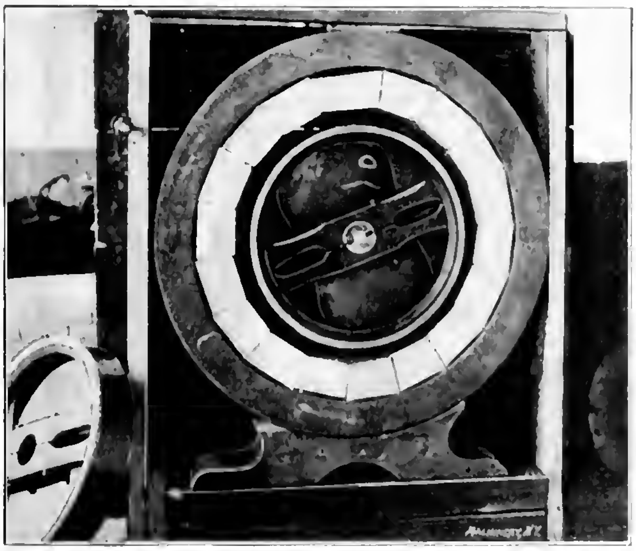


Fig. 1. Pulley No. 1 in place in the Testing Apparatus

The pulleys were inclosed in a cast-steel ring four inches thick, having a lining of wooden blocks and covered at the sides with heavy oak planking. The shaft used was 1 and 7-16 inches in diameter and was driven by a Dow steam turbine of about twenty horse-power. The speed was measured by a pendulum tachometer, connected to the turbine shaft through belting and speed reducers. This arrangement was calibrated at a speed of 5,000 revolutions per minute and found to be correct.

The names of the manufacturers of the pulleys are not given, but the illustrations show the types of wheels represented. The pulleys were furnished by the makers and presumably were all of the best quality.

Pulleys Nos. 1 and 2 were alike, having the usual built up rim with two joints. The spokes consisted of two parallel bars either side of the split and clamped on the bushing at the hub by transverse bolts. (See Fig. 1.) The rim was reinforced on each side of the joints by wooden brackets or webs and these latter contributed to the failure of the rims.

Figs. 2 and 3 show the two pulleys after bursting. Instead of the rim failing at the middle of the unsupported span, as might have been expected, the failure occurred in both cases at the ends of the arms, the centrifugal force of the brackets before mentioned forcing the rim apart as shown in the illustrations. This force was so great as to rupture the arms in both pulleys.

In pulley No. 1 the arms were cross-grained but in the second pulley the centrifugal force ruptured and splintered sound, straight-grained lumber, as seen in Fig. 3. The only sign of failure at the 90-degree points was the disjointing of the rim caused by the opening outward at the ends of the arms. The bursting occurred at speeds of 2,200 and 2,250 revolutions per minute respectively, or linear speeds of 230 and 236 feet per second.

Pulleys Nos. 3 and 4 differed from the preceding in having arms which form a letter X inside the rim, as shown in Fig. 4. The pulleys were fastened to the shaft by clamp bolts through the arms and the rim joints were held together by malleable iron lugs fastened with one bolt each. The rims in both instances failed at the mortises where the arms were inserted, as may be seen in Fig. 9, which shows pulley No 4 after bursting. The centrifugal force of the lugs and bolt probably helped to rupture the wheel at these points. The bursting speeds were 2,000 and 1,700 revolutions per minute, or 210 and 178 feet per second.

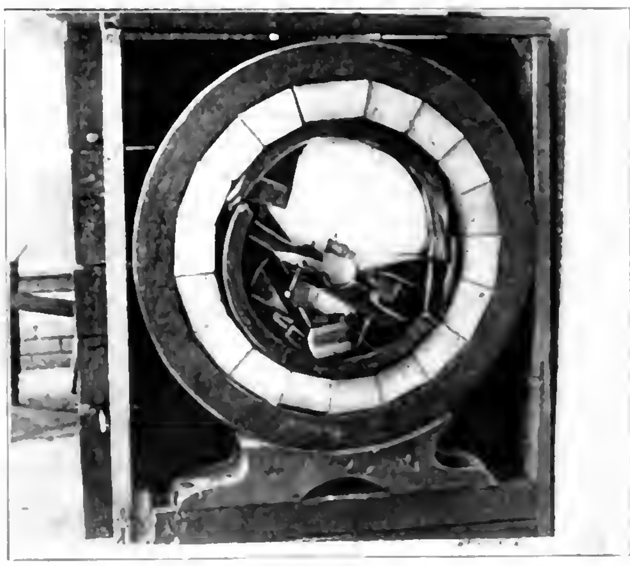


Fig 2 Pulley No 1 after Bursting

Pulley No. 5 was similar to those numbered 1 and 2 having the same parallel arms either side of the split and the same reinforcements each side of the rim joint As might have been expected, it failed in the same manner at the joints, as may be seen in Fig. 5, which shows its appearance after rupture. The weakening of the rim by the insertion of the arms, coupled with the additional centrifugal force due to the brackets, was the cause of the failure. This pulley, however,

PROF. C. H. BENJAMIN was born at Patten, Maine, in 1856. He served a machinist's apprenticeship at the shop of Benjamin and Allen, Oakland, Me., and took the course in mechanical engineering at the University of Maine, receiving the degree of M. E. He was employed by the McKay Sewing Machine Association, and later as assistant manager of the McKay and Bigelow Heeling Machine Association. He was appointed professor of mechanical engineering at the University of Maine, and later to the same position at the Case School of Applied Science, Cleveland, O., where he has since remained. Prof. Benjamin has become closely identified with the work of Case School and has impressed his individuality upon it to a marked degree. Among the interesting and original work that has been done under his direction is that of the experimental determination of the stresses in rotating bodies, such as flywheels, pulleys, etc. From 1900 to 1902 he was supervising engineer for the City of Cleveland and was placed in charge of the movement for smoke abatement in that city.—EDITOR.

proved to be considerably stronger than any before tested, the bursting speed being 2,450 revolutions per minute, or 257 feet per second.

Pulley No. 6 was made by the same firm as No. 5 and had a

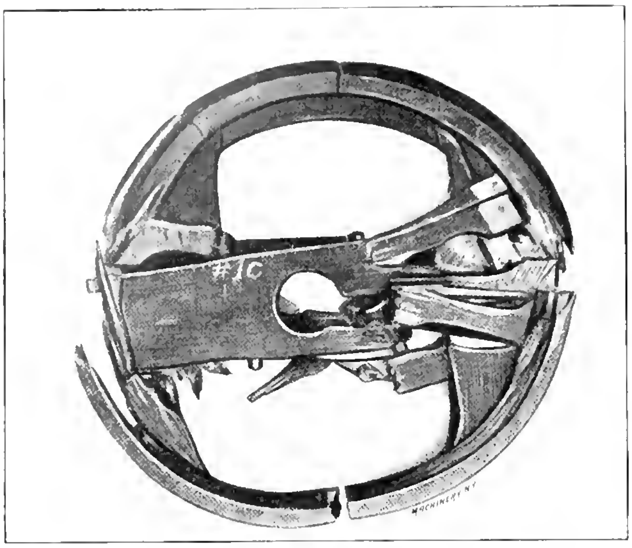


Fig. 3. Pulley No. 2, after Rupture.

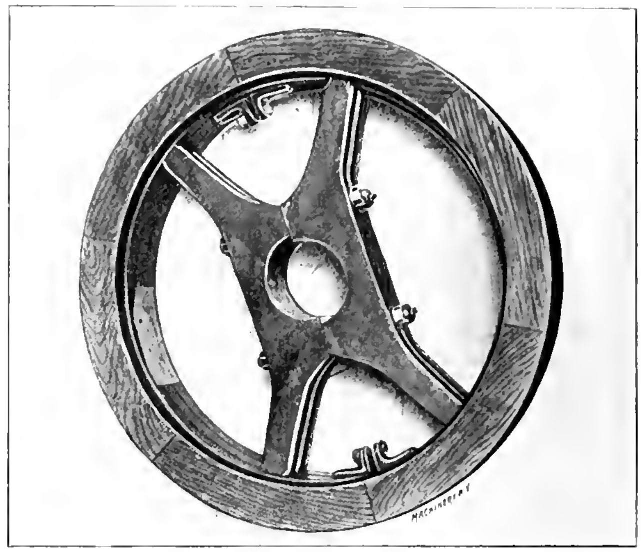


Fig. 4. Pulley No. 3.

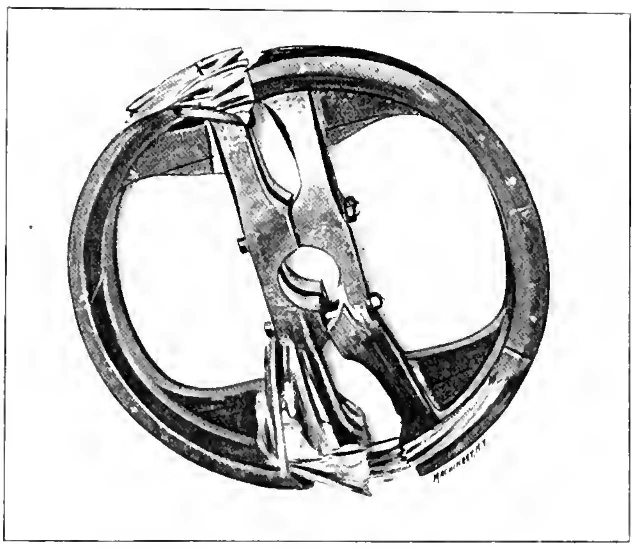


Fig. 5. Pulley No. 5, after Rupture.

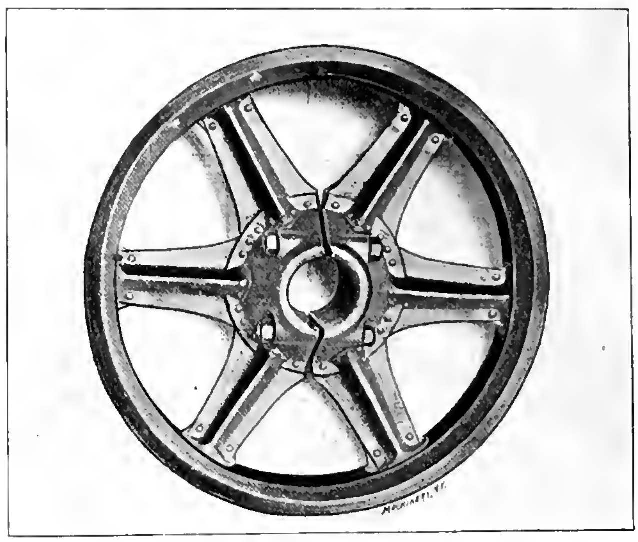


Fig. 6. Pulley No. 6, Steel Spokes.

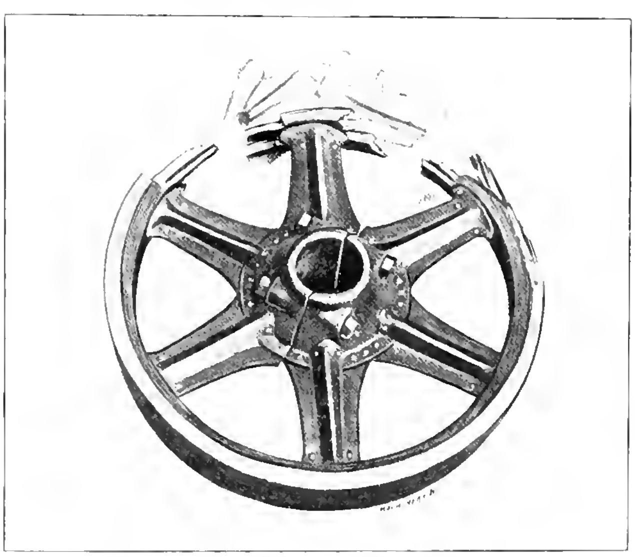


Fig. 7. Pulley No. 6, after Rupture.

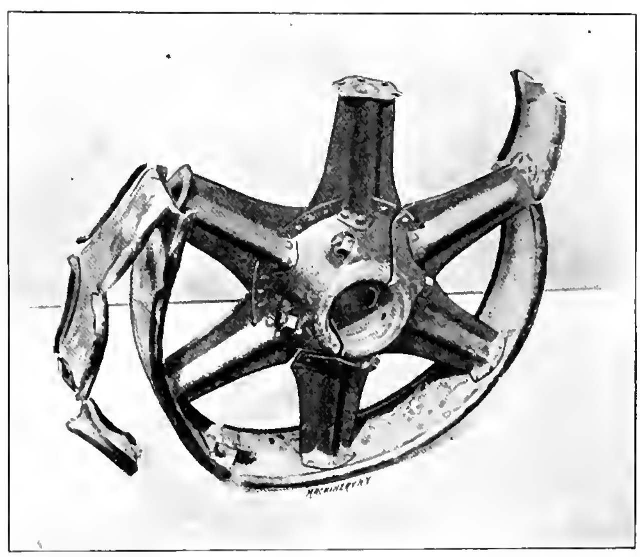


Fig. 8. Pulley No. 7, all Steel.

similar rim. The arms and hub, however, were made of pressed steel, as shown in the illustration, Fig. 6, which shows this pulley before rupture. The speed of bursting was just the same as in the preceding case, viz., 2,450 revolutions per minute, and the rupture occurred at one of the arms next one of the joints. (See Fig. 7.) The thin webs of the arms were inserted in the rim and steel pins driven through transversely to hold them. The wood outside these pins split and peeled off, carrying with it the rim on either side. The joint in the rim appeared to have nothing to do with the failure.

Pulley No. 7 was only 20 inches in diameter and was made

throughout of pressed steel. The arms and hub were the same as in the pulley last described but the rim, being of steel with rolled edges, was riveted to flanges on the ends of the arms as shown in Fig. 8, which represents this pulley as it appeared after bursting.

As may be clearly seen in the lower part of the figure each joint in the rim was secured by one bolt passing through sheet metal lugs riveted to inside of rim. The weakness of these lugs was the immediate cause of the failure. At a speed of 2,500 revolutions per minute the centrifugal force of the joint bolts caused the lugs to bend and the rim to open at the joints nearly one-half inch. The pulley finally failed at 2,550 revolutions per minute, or a rim speed of 223 feet per second, one

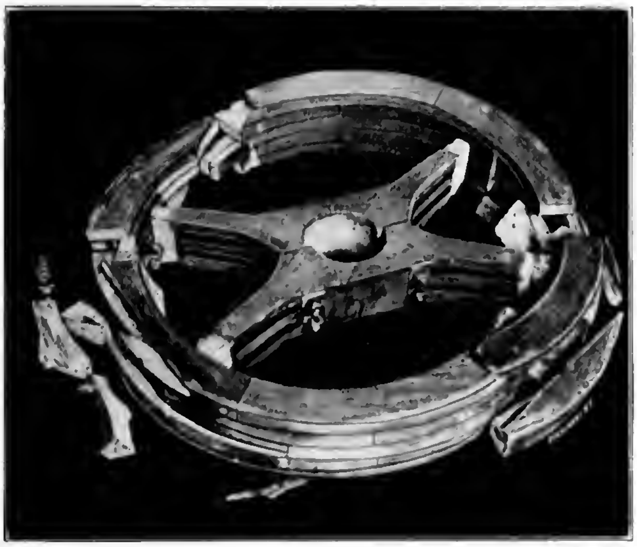


Fig. 9. Pulley No. 4, after Rupture.

of the bolts pulling out of the lug which held it and allowing the rim to open and bend back. See Fig. 8.

Pulley No. 8 was without arms, having a solid wooden web with cast-iron flanged hub. It was found impossible to burst this wheel with the power at command and the attempt was abandoned. A speed of 4,450 revolutions per minute, or a rim speed of 467 feet per second, was attained and this made no impression whatever upon the integrity of the rim.

The following table gives a resumé of the results of the experiments:

Table.

No.	Description.	Size.	R. P. M.	Feet per Sec.
1.	Wood Split	24″ × 4″	2,200	230
2.	Wood Split	24″ × 4″	2,250	236
3.	Wood Split	24″ × 4″	2,000	210
4.	Wood Split	24″ × 4″	1,700	178
5.	Wood Split	24″ × 4″	2,450	257
6.	Steel Arms	24″ × 4″	2,450	257
7.	All Steel	20″ × 4″	2,550	223
8.	Solid Web	24″ × 4″	4,450	467

(No. 8 was not broken.)

In comparing these pulleys with each other and with cast-iron pulleys of the same size it will be necessary to compute the centrifugal tension of wood as compared to that of iron or steel.

Let S = centrifugal tension (pounds per square inch).
Let v = velocity in feet per second.
Let w = weight of material per cubic inches.
Then it can be readily proved that for thin rims

$$S = \frac{12wv^2}{g}$$ if we neglect bending.

For iron and steel this reduces to $S = v^2/10$ approximately. The weight of dry hardwood, such as maple, is .027 pounds per cubic inch, or almost exactly one-tenth that of iron. We may then write for wood:

$$S = v^2/100.$$

(The material used in most of the pulleys tested was maple.) Assuming the tensile strengths as follows:

Soft Steel	60,000
Cast Iron	18,000
Wood	10,000

we have the values for linear velocity to produce rupture:

	Feet per Sec.
Soft Steel	775
Cast Iron	425
Wood	1,000

For pulleys two feet in diameter this corresponds to revolutions per minute of 740, 406 and 955 respectively.

Repeated tests on cast-iron pulleys and small flywheels have shown that a whole rim of this material will fail at speeds of from 350 to 420 feet per minute, depending upon the quality of the rim and the amount of bending between the arms. If the wood in a pulley rim were as homogeneous as the cast iron, speeds of from 800 to 1,000 feet per second could undoubtedly be attained.

It has been noticed that pulley No. 8 was uninjured by the speed of 467 feet per second. There are two causes for the failure of wooden pulleys at high speeds, the various joints in the rim and the mortises made to receive the arms. Furthermore, any attempt to strengthen the rim by wooden or metal braces and lugs usually does more harm than good on account of the centrifugal force of the added parts.

It should be said, however, to the credit of the wooden pulley, that with the exception of No. 4 the split pulleys tested ran at higher speeds before bursting than cast-iron wheels with rim joints.

The average bursting speed of thirteen cast-iron wheels of this same diameter and width having flanged rim joints, was exactly 200 feet per second, the lowest speed being 164 feet per second and the highest 230 feet per second. In other words, the average rim joint in such a wheel will stand only half the speed of the solid metal and is therefore only one-quarter as strong.

A four-foot split pulley of cast iron with flanges at joints burst at a speed of only 600 revolutions per minute, or about 125 feet per second. This pulley was of the usual type of split pulleys, having been cast in one piece with cored openings in the flanges at hub and rim. After the pulley was bored and turned the two halves had been broken apart with wedges. It will be seen that the wooden pulleys tested were nearly four times as strong as the last mentioned.

After all, the strength of a pulley rim, be it iron or steel, is a question of the efficiency of the joint. Had pulley No. 7 been properly fastened together at the joints in the rim, its bursting speed would have been at least half that of the solid metal, whereas it was only $223/775 = 0.288$ of that speed showing the efficiency of the joints to have been about one-twelfth.

The actual factor of safety in the pulleys tested, as they would be used in practice is ample. Assuming a maximum belt speed of 6,000 feet per minute, or 100 feet per second, the average speed factor is 2.27, giving a stress factor of over five. This is sufficient for machinery which is not subjected to shocks or reversals.

In designing pulleys of any material for high-speed service great care should be taken to avoid the use of balance weights or other added metal which will increase the centrifugal tension without a corresponding increase of strength.

* A four-foot cast-iron pulley with a whole rim was tested by the writer and burst at a speed of 1,100 revolutions per minute, or 230 feet per second. The cause of failure was a balance weight of $3\frac{1}{2}$ pounds inside the rim. At the given speed the centrifugal force of this weight would be 2,760 pounds, and as it was located midway between the arms at the thinnest portion of the rim, it would enormously increase the stress at that point.

The deterioration of wooden rims on account of loosening of the joints from moisture or vibration has not been considered in this article as the pulleys tested were all new and fresh from the factory.

* * *

A gentleman who says he has been twenty years in the navy and is "getting on in years, so naturally has a tired feeling after hard work," contributes his experiences in an advertisement for the benefit of a certain cocoa firm as follows: "Whilst cruising the other day, one of the blades of our propeller came off, and I had to go and solder a spare one on. It was rather a long and tiring job, and I sincerely believe if it hadn't been for ———— cocoa, I should never have got through it." We should think not, indeed!—*Page's Magazine.*

* Trans. A. S. M. E., Vol. XXVI., 19[illegible].

VARIABLE SPEED MECHANISMS.—4.

EXPANDING PULLEYS.

Of the large class of variable speed devices known as expanding pulleys, only a few of the recent patents have been chosen for the purpose of illustration in this series. A number of meritorious early patents have been ignored, it being thought best to show the later development of the art in this class.

Fig. 38 is a speed-changing pulley patented by August Harding, January 10, 1888, No. 376,150. The pulley really consists of two pulleys mounted on the same shaft and so constructed that the one expands as the other contracts. The pulleys are mounted in a swinging frame *A* and are connected by independent belts to the driving and driven shafts. As one pulley, say *B*, is expanded the other pulley B_1 contracts and the swinging frame shifts to the left, thus maintaining equal tension on the two belts. The mechanism by which this reciprocal action of the two pulleys is obtained consists of a number of two-armed segments *C* pivoted centrally between the two pulleys. These segments are toothed on their inner faces and the teeth engage the grooved spool mounted on the shaft *D*, which is kept normally in a central position by coil springs. The shaft *D* is splined so that it turns with the pulley but is free to move longitudinally, being shifted by the levers *E* E_1. The longitudinal motion of the shaft rocks the segments on their pivots and expands one pulley while the other contracts.

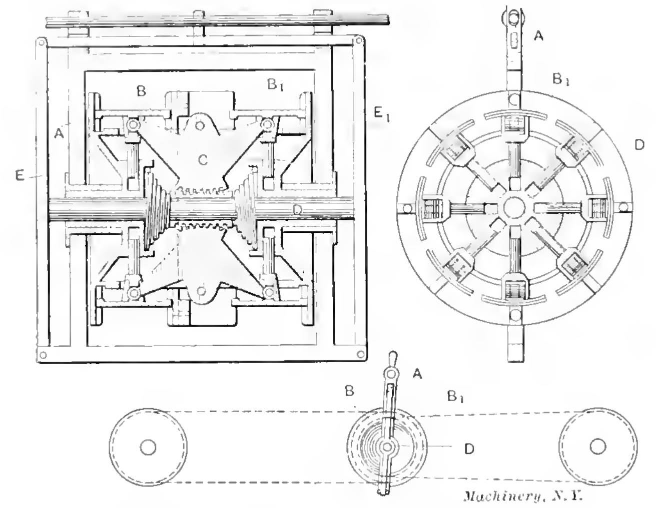


Fig. 38. August Harding's Patent, No. 376,150, January 10, 1888.

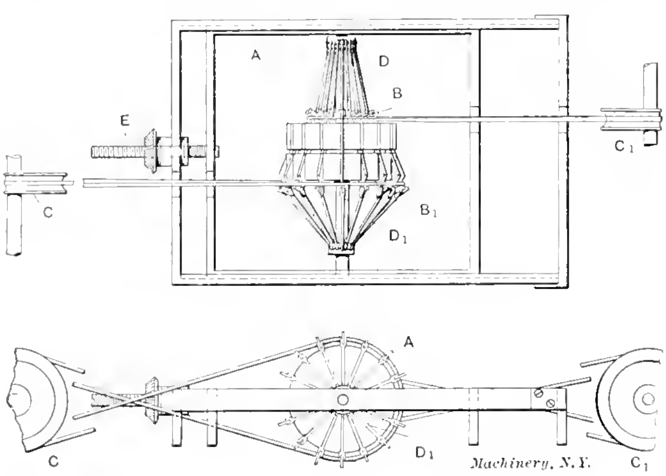


Fig. 39. Patent No. 580,327, granted J. McCraith, April 6, 1897.

Another speed-changing device very similar in principle to that patented by Mr. Harding is patent No. 580,327, by J. McCraith, April 6, 1897. This device, however, is only adapted to the use of round belts, the belt faces consisting of a series of notched levers *B* and B_1 pivoted at the centers and connected by a series of links *D* D_1 to sleeves sliding on the shaft. Frame *A* in which the expanding pulley is mounted, instead of having a swinging support, slides in another frame and its motion is controlled by a screw which is operated by a bevel gear and hand-wheel not shown. It is obvious that the movement of the frame *A* accomplishes a change of speed inasmuch as the pull of the belt being diminished on one side and being increased on the other, the levers will automatically rock on their pivots and increase the diameter of one member and decrease that of the other.

The variable speed mechanism shown in Fig. 40 was patented by Milton O. Reeves, April 26, 1898, No. 603,067. In this device two pairs of cones *C C* and $C_1 C_1$ are mounted on parallel shafts and are connected by levers *D* D_1 in such a way that, as one pair of cones approach each other, the other pair separate. A leather belt with wooden cross-pieces, having the ends tapered to conform to the tapers of the cones, is mounted on these cones. Motion is conveyed from one shaft to the other by a frictional contact of the cones against the ends of the wooden cross-pieces. To take care of the heavy end-thrust caused by this arrangement, the cones are provided with ball thrust bearings. Two earlier patents were granted to Reeves, Nos. 583,402 and 588,354, for inventions covering the elementary features of this device.

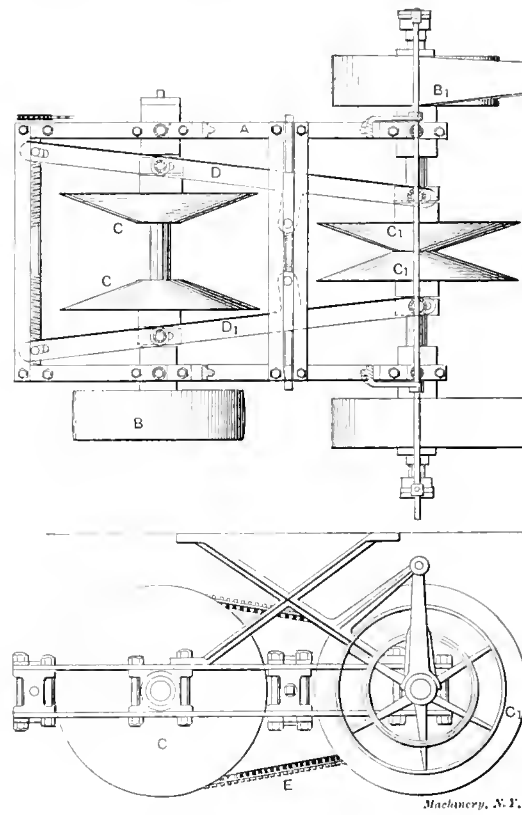


Fig. 40 Milton O. Reeves' Patent, No. 603,067, April 26, 1898.

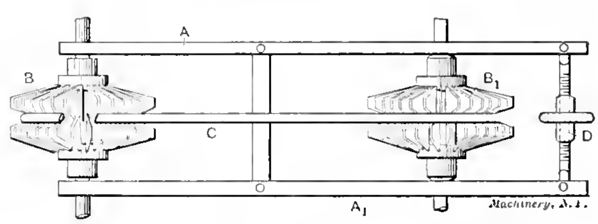


Fig. 41. Expanding Pulley Patented by C. E. Brooks, March 6, 1900, No. 644,702.

The expanding pulley variable speed device patented by C. E. Brooks, March 6, 1900, No. 644,702, essentially consists of pulleys *B* B_1, frame *A*, belt *C* and the adjusting screw *D*, Fig. 41. The pulleys consist of intermeshing tapered leaves mounted on hubs and sliding longitudinally on supporting shafts. A V-groove is formed between the intermeshing leaves on each pulley, which, of course, expands and contracts with the longitudinal movement of the separable hubs. This movement is controlled by means of a right- and left-hand nut *D* which rocks the members *A* A_1 of the frame upon their pivots, causing the hubs of one pulley to approach, thus increasing the diameter of the V. The pull of the belt decreases the diameter of the V in the opposite pulley, thus keeping the hubs against the sides of the frame members *A* A_1.

The device shown in Fig. 42, patented by C. A. Gourgoulin

and A. H. Croizier, June 26, 1900, No. 652,541, is a reversing and speed-changing gear but the reversing feature is incidental and forms no essential part of the speed-changing mechanism. This latter consists of two pairs of conical pulleys A A_1, which are made with alternate sections of their inner faces cut out so that the inner face contour of one cone may enter that of the other, and *vice versa*, as the two are

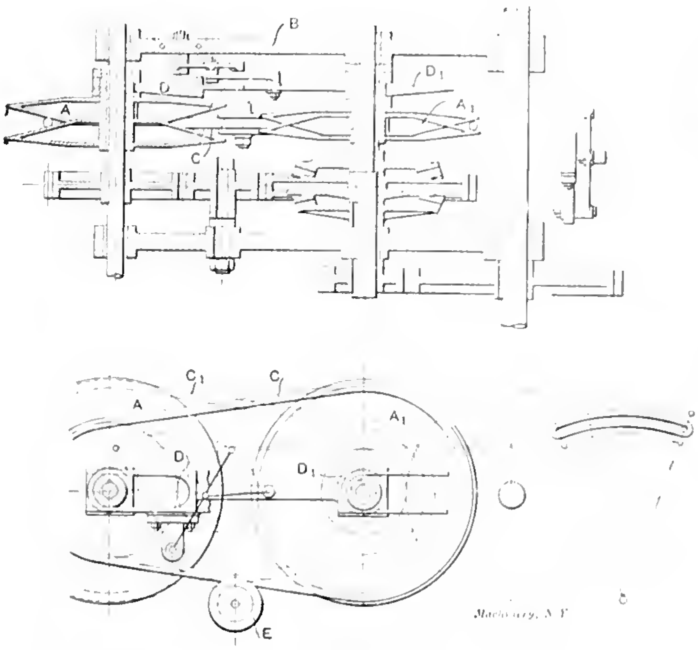


Fig. 42. Patent No. 652,541, granted to C. A. Gourgoulin and A. H. Croizier, June 26, 1900

approached. Approach, of course, increases the diameter of the V-groove between them and the contrary action of the other pulley decreases this diameter. This movement is made in unison by means of two wedges D D_1, which are connected by a short rod. To this rod is pivoted a link which is connected to a hand lever not shown. The pulley E appears to have no necessary function except that it may be used as a tightener when the round belt stretches with use.

Fig. 43 is made from the drawing accompanying patent specification No. 658,655, granted to Ernst Lang, September 25, 1900. In this invention the pulley face segments B on which the belt is carried, are pivoted nearer the peripheries

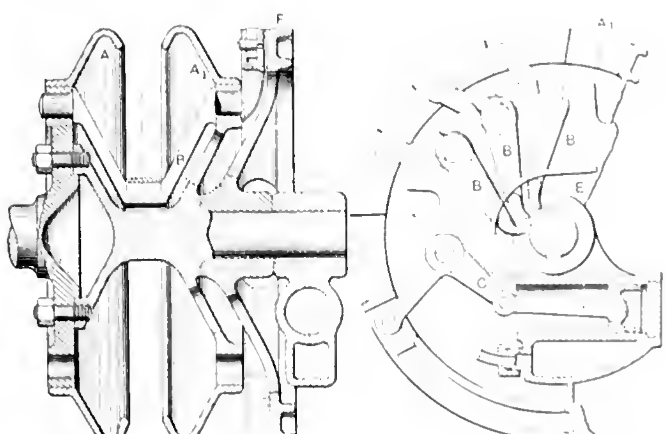


Fig. 43. Ernst Lang's Patent, No. 658,655, granted September 25, 1900

of A A_1. To the outer end of these rocking pieces are short cranks, all connected to a ring F, which is mounted concentric with the shaft. This ring is operated by fluid pressure in the cylinder D. The shape of the members B in the part in contact with the belt E is such that rounded surfaces are presented to the inner sides of the belt in all positions that they may be placed by the action of the piston in cylinder D.

The apparatus, Fig. 44, for transmitting motion at variable speed, patented by A. Wache and A. Krieger, November 19, 1901, No. 687,090, consists of expanding pulleys having rims made on the "lazy tongs" or pantagraph principle, thus giving the belt a more or less continuous surface for operation. The rims are expanded and contracted by longitudinal movement of the sleeves mounted on their shafts and controlled by B, as shown in one view, or D, in the other, the actions being the same in each case. The inner end of the sleeves is grooved and engages the toothed ends of rocking levers E E. These levers are slotted and the slots engage pins on the inner side of the bars of the rims. As these levers are shifted inward they carry the pulley rim along. The connection between

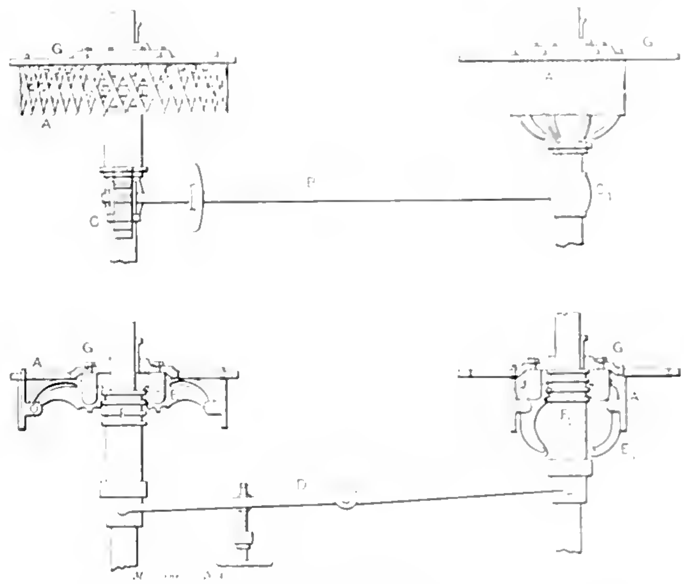


Fig. 44. Patent No. 687,090, granted to A. Wache and A. Krieger, November 19, 1900

the two pulleys is such, of course, that the action is simultaneous, one pulley expanding as the other contracts. Disks G G_1 are provided with slots to guide and sustain the flexible rims against lateral displacement.

Patent No. 687,546, shown in Fig. 45, was granted to A. Sinclair, November 26, 1901. In this invention there are two pairs of opposing cones mounted on parallel shafts, each cone having narrow slots in which are loosely fitted movable strips C C_1. The angle of the cones is so chosen that longi-

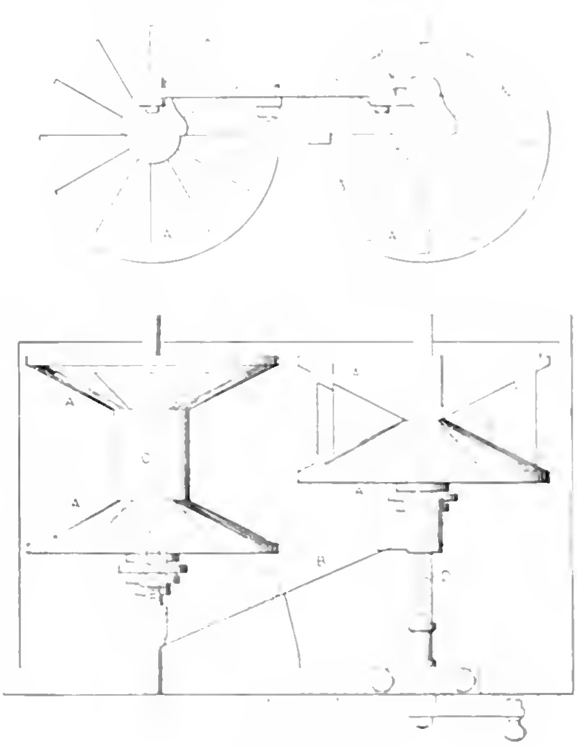


Fig. 45. A. Sinclair's Patent, No. 687,546, granted November 26, 1901

tudinal movement of one cone toward the other forces the strips outward, thus expanding the belt diameter. This movement is effected co-ordinately by means of lever B, connecting each pair of cones. The lever is operated by the screw D, situated above the shaft on the right. It will be observed that since only one cone of each pair is given longitudinal

movement, the effect is to decrease the available belt width, making it only about one-half of the full length of the strips $C\ C_1$.

Expanding pulleys in general present broken surfaces to support the belt, but the invention of A. G. S. Lyford, April 9, 1901, No. 671,895, is designed to overcome this defect, the segments of the pulley faces being made to overlap as they contract or expand and thus preserve an unbroken contour. The pulleys $B\ B_1$, Fig. 46, are mounted in a frame A and the

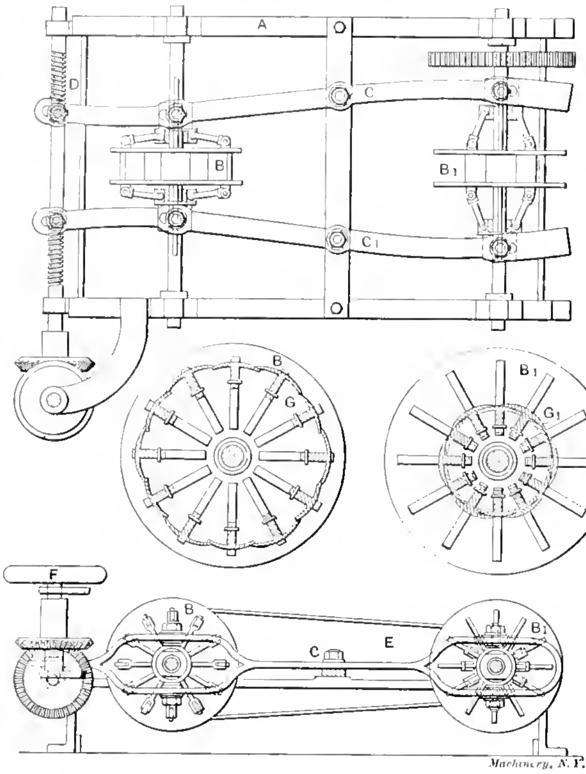


Fig. 46. Patent No. 671,895, granted to A. G. S. Lyford, April 9, 1901.

segment portions, which slide in radial slots, are connected by links with collars on the shafts, which, in turn, are connected to levers $C\ C_1$ pivoted in their centers. These levers are operated by the right- and left-hand screw D, thus giving co-ordinate motion to both sets of pulley segments, so that one expands as the other contracts. The cross-sectional views shown at $G\ G_1$ illustrate how the segments of the rim overlap so as to present an unbroken belt surface.

In the invention of C. L. Rosenqvist, patented October 25, 1904, No. 773,426, the expanding pulleys are mounted on co-

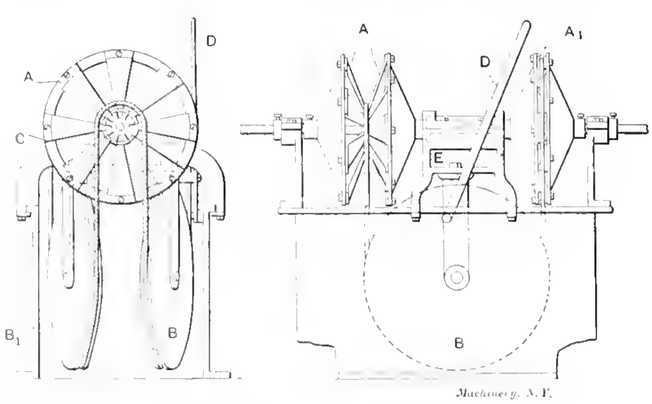


Fig. 47. C. L. Rosenqvist's Patent. No. 773,426. Granted October 25, 1904.

axial shafts and are connected by a round belt running in the V-grooves formed between $A\ A$ and $A_1\ A_1$. The belt is supported between the two pairs of cones by the idlers $B\ B_1$, which are pivoted so as to swing to accommodate the varying positions of the belt as the pulleys are expanded and contracted. In this construction it is apparent that the thrust of one member of the cones A is balanced by that of the opposite member of the cones A_1, so that the movement of lever D, which is connected to the shifting mechanism E, meets little resistance.

STANDARD HYDRAULIC PIPE FLANGES.

FRANK B. KLEINHANS.

Hydraulic machinery is used to-day in almost every line of work. In rolling mills and steel works the hydraulic system is indispensable. We also find a large field for this class of machinery in cotton presses, filter plants, riveting machinery and so on. Now with this large field for the use of hydraulic machinery there is of course a great deal of pipe fitting required. Each builder has his own idea in regard to the method of coupling the pipes, some of which are good and practical, while others are forever giving trouble. The essential features of a high-pressure pipe coupling are as follows: First, the

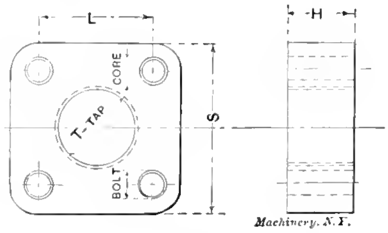


Fig. 1.

coupling should be absolutely water-tight; second, it should be so designed as to admit of being easily put together or taken apart; third, it should be simple and have the least number of parts; fourth, it should be low in price.

Fig. 1 represents a coupling which has all of the above features. This principle has been used for a number of years under the most severe strain of hydraulic piping. S is one of the sides of this square flange, L is the distance between the bolt centers, and H is the thickness of the flange. The coupling is arranged for four bolts of such size as to be suitable for

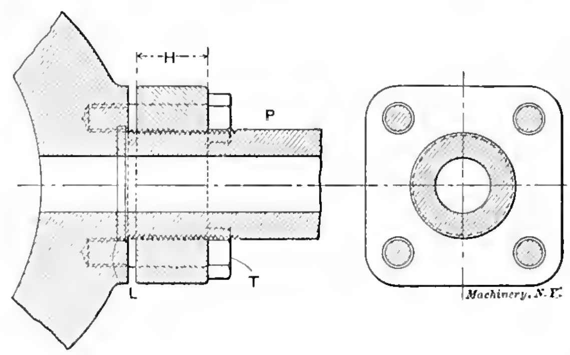


Fig. 2.

3,000 pounds water pressure. It is rare that the water pressure in any accumulator system is above 2,500 pounds; therefore this flange will be used for any pressure from 500 to 3,000 pounds. The flange would of course be stronger than necessary for the low pressure, but as this is a standard flange it is cheaper to use the same size for different pressures between these limits, as the outside diameter of the pipe is the same whether the pipe be merchant, extra or double-extra strong.

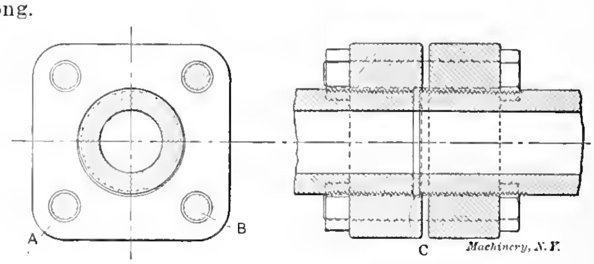


Fig. 3.

The tap T is made a medium pitch, as noted in the accompanying table, and is a straight thread. One arrangement of this flange is shown in Fig. 2. The double extra heavy pipe P is threaded about one inch more than the thickness of the flange H. The flange is then screwed onto the pipe until the end of the pipe projects about one quarter of an inch. A leather washer L is placed into a corresponding recess in the cylinder, and serves to pack the joint. The four tap bolts are used to draw the pipe against this leather packing, and thus seal the joint. These bolts should always be made tap bolts in-

stead of studs, for the reason that in nearly every case it is impossible to move a pipe longitudinally far enough to slip the flange over the studs.

It is not an infrequent thing to be obliged to couple together two pieces of pipe for a continuous line. The arrange-

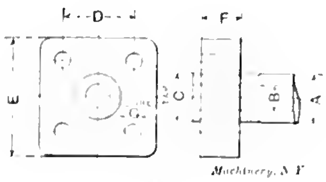


Fig. 4.

ment of the flanges for this case is shown in Fig. 3. One of the flanges is counterbored, as shown at *C*, for a leather washer. The counterbore is the same diameter and the thickness of the washer is the same as that which would be used in connecting up direct with the cylinder. See Fig. 2.

Size of Pipe	A	B	Area	Tap. C	Tap. Thds.	D	E	F	G	Bolt.	Washer. Dia.	Washer. Thick
$1\frac{1}{4}$	1.66	.88	2.2	$1\frac{11}{16}$	12	$2\frac{1}{4}$	$3\frac{1}{2}$	$1\frac{3}{8}$	$\frac{11}{16}$	$\frac{5}{8}$	$1\frac{3}{4}$	$\frac{3}{16}$
$1\frac{1}{2}$	1.9	1.08	2.8	$1\frac{7}{8}$	10	$2\frac{3}{4}$	$4\frac{1}{4}$	$1\frac{3}{4}$	$\frac{13}{16}$	$\frac{3}{4}$	$1\frac{15}{16}$	$\frac{3}{16}$
2	2.37	1.49	4.4	$2\frac{3}{8}$	10	$3\frac{1}{4}$	5	2	$\frac{15}{16}$	$\frac{7}{8}$	$2\frac{7}{16}$	$\frac{3}{16}$
$2\frac{1}{2}$	2.87	1.75	6.5	$2\frac{7}{8}$	10	$3\frac{3}{4}$	6	$2\frac{1}{4}$	$1\frac{1}{16}$	1	$2\frac{15}{16}$	$\frac{3}{16}$
3	3.50	2.28	9.6	$3\frac{1}{2}$	10	$4\frac{1}{2}$	7	$2\frac{1}{2}$	$1\frac{5}{16}$	$1\frac{1}{4}$	$3\frac{5}{8}$	$\frac{1}{4}$
$3\frac{1}{2}$	4.00	2.71	12.5	4	10	5	$7\frac{3}{4}$	$2\frac{3}{4}$	$1\frac{7}{16}$	$1\frac{3}{8}$	$4\frac{1}{8}$	$\frac{1}{4}$

The bolt holes *A* are cored one-sixteenth larger than the bolt, and the bolts are rough forged. These flanges are made of cast iron and have no machine work in them except chasing the thread and in some cases counterboring for a washer.

The dimensions for the different size flanges are given in the cut, Fig. 4, while the table gives some data on the external and the internal diameter of XX pipe.

* * *

AMOUNT OF AIR REQUIRED FOR VENTILATION.

Under the general conditions of outdoor air, namely 70 degrees temperature and 70 per cent of complete saturation, an average adult man, when sitting at rest in an audience, makes 16 respirations per minute of 30 cubic inches each, or 480 cubic inches per minute. With 70 degrees temperature and 70 per cent humidity, the air thus inhaled will consist of about one-fifth oxygen and four-fifths nitrogen, together with about 1 7-10 per cent of aqueous vapor, and 4-100 per cent of carbonic acid. By the process of respiration the air will, when exhaled, be found to have lost about one-fifth of its oxygen by the formation of carbonic acid, which will have increased about one hundred fold, thus forming about 4 per cent, while the water vapor will form about 5 per cent of the volume. In addition, the exhaled air will have warmed from 70 degrees to 90 degrees and, notwithstanding the increased proportion of carbonic acid—which is about one and one-half times heavier than air—will, owing to the increase of temperature and the levity of the water vapor, be about three per cent lighter than when inhaled. Thus it will be seen that this vitiated air will not fall to the ground as has often been presumed, but will naturally rise above the level of the breathing line, and the carbonic acid will immediately diffuse itself into the surrounding air. In addition to the carbonic acid exhaled in the process of respiration, a small amount is given off by the skin. Furthermore, $1\frac{1}{2}$ to $2\frac{1}{2}$ pounds of water are evaporated daily from the surface of the skin of a person. If the air supply at 70 degrees is assumed to have a humidity of 70 per cent and to be saturated when it leaves the body at a higher temperature, then at least 4 cubic feet of air per minute will be required to carry away this vapor.

Taking into consideration these various factors, it becomes evident that at least $4\frac{1}{2}$ cubic feet of fresh air will be required per minute for respiration, and for the absorption of moisture and dilution of carbonic acid gas from the skin. This, however, is only on the assumption that any given quantity of air, having fulfilled its office, is immediately removed without contamination of the surrounding atmosphere; but this condition is impossible, for the spent air from the lungs, containing about 400 parts of carbonic acid gas in 10,000, is immediately diffused in the atmosphere. The carbonic acid does not fall to the floor as a separate gas, but is intimately mixed with the air, and equally distributed throughout the apartment.

It must then be evident that ventilation is in effect but the process of dilution and that when the vitiation to be maintained in the apartments is decided, the necessary constant supply of fresh air to maintain this standard may be very easily determined. For the purpose of calculation, 0.6 cubic feet per hour is accepted as the average production of carbonic acid by an adult at rest, and the proportion of this gas in the external air is as 4 parts in 10,000. If, therefore, the degree of vitiation of the occupied room be maintained, say at 6 parts in 10,000, there will be permissible an increment of only 2 parts in 10,000 above that of the normal atmosphere, or 2 divided by 10,000 equal .0002 of a cubic foot of carbonic acid in each cubic foot of air. The 0.6 cubic foot of carbonic acid produced per hour by a single individual will, therefore, require for its dilution to this degree 0.6 divided by .0002, equal 3,000 cubic feet of air per hour.

These figures are generally applicable to the ventilation of schools, churches, halls of audience and the like, where the occupants are reasonably healthy and remain at rest. But the absolute air volume to be supplied cannot be specified with certainty in advance, without a thorough knowledge of all the conditions and modifying circumstances, in fact, the climate, the construction of the building, the size of the rooms, the number of occupants, their healthfulness and their activity, together with the time during which the rooms are occupied, all have their direct influences. Under all these conditions, it is readily seen that no standard allowance can be made to suit all circumstances, and results will be satisfactory only in so far as the designer understandingly, with the knowledge of the various requirements as they have here been given, makes such allowance.

* Extract from Treatise on Ventilation and Heating, by B. F. Sturtevant Co. Boston Mass.

* * *

WEAR OF TURBINE BLADES.

The firm of Sulzer Bros., the famous German builders of steam engines, have conducted extensive experiments upon the wear of the blades of steam turbines, to determine the cause of this trouble. It is undoubtedly a fact that the continued success of the turbine hinges largely upon this one point of blade wear. If the blades of a particular machine should have to be renewed frequently, because of deterioration and consequent loss in economy in the use of steam, that turbine would not make a commercial success. The Sulzer experiments indicate that the wear is due to the particles of water in the steam and that if water is present in steam that flows at extremely high velocities, as is the case in single-stage turbines, the cutting is apt to be rapid. With superheated steam, or with saturated steam in multi-stage turbines, the cutting is not a serious matter.

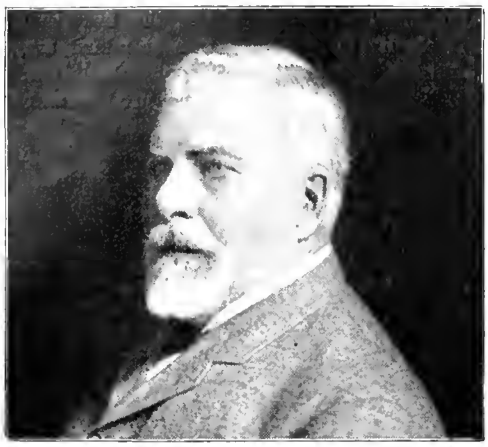
The above experiments are in a measure confirmed by the experience of those using steam injectors for boiler feeding. This cutting action seldom occurs in the steam nozzle, but frequently does take place in the combining tube where water is flowing at comparatively low velocities. It should be noted, however, that this water is mainly the feed water pumped up by the injector, and contains more or less mineral matter, the extent of the cutting probably depending upon the quantity of such foreign particles entrained in the water. In the case of the turbine, however, the water particles suspended in the steam are or should be nothing but pure distilled water, formed by steam condensation after leaving the boiler. Probably no injector would give trouble by cutting, if used to pump distilled water, assuming, of course, that the tubes were of a material that would not be corroded by the water. We also believe that no turbine, in which the steam is used at moderate velocity, will be likely to deteriorate rapidly under ordinary operative conditions.

* * *

A steel scale makes a handy screwdriver—but always use your neighbor's.

FIFTIETH ANNIVERSARY OF THE CRANE CO.

The Crane Co., Chicago, Ill., celebrated their fiftieth anniversary July 4. All of the company's branch house managers took part in the celebration. Excursions were made to various points of interest, the visitors were entertained for a part of the time at the country residence of Mr. R. T. Crane, and on July 6, the last day of the proceedings, the company gave a picnic to all its employees and their families. About 10,000 people attended this picnic.



R. T. Crane, the President and Founder of the Crane Co.

Richard Teller Crane, the founder of the Crane Co., was born at Paterson, N. J., in 1832. His parents were poor, but wished their sons to learn trades and young Crane had instruction and experience in several branches of mechanical work. He served four years in a brass foundry and also worked as a machinist for several firms, including R. Hoe & Co., New York. In 1855 he was thrown out of employment and went to Chicago, where he had an uncle, the late Martin Ryerson, who was engaged in the lumber business. He consulted with his uncle in regard to going into business for himself, and finally opened a brass foundry in one corner of his lumber yard. Being anxious to see how the furnace and sand would work, and having some patterns ready, he took off a heat the next day, notwithstanding that it was the Fourth of July. The sand used was found on the premises and the first castings were couplings used in connecting lightning rods. Business prospects looking good, Mr. Crane sent for his brother, Charles S. Crane, who came in the fall, and who was connected with the business until 1871. Shortly after his arrival they decided to go into the making and finishing of brass goods. A foot lathe was purchased, and the manufacture of brass engine trimmings begun. A few months later a room with power was rented, and the following spring a small three-story frame building was erected and equipped for power with a six horse power portable engine.

After the breaking out of the civil war the enormous demand of the government for all sorts of material made it necessary to enlarge the brass plant and the manufacture of brass globe valves, check valves, steam and gas cocks was begun. An iron foundry was started, and the building, in a small way, of machinery and the making of a few articles belonging to the steam fitting line was undertaken. About the same time a small butt-weld pipe mill, the first mill west of Pittsburg, was built on ground where the Crane Co. still has a pipe mill. In the same year (1864) the property where the present brass department is located, known as No. 10 North Jefferson Street, was purchased and the first malleable iron foundry outside of the Eastern States started. This foundry was on the second floor and is said to be the first instance of a foundry being placed above the ground floor. The manufacture of both malleable and cast iron fittings was commenced.

In 1865 the business was incorporated and the name of the firm was several times changed, becoming in 1890 the Crane Co. Fortunately the plant escaped the fire of 1871 and the demand for their goods during the rebuilding of the city required a large increase in their facilities. Many extensive additions and new buildings have been added to the plant from time to time, since 1871, however, due to the normal and steady growth of the business. In 1881 another pipe mill was erected, in which a Siemens gas furnace was employed in the manufacture of lap-welded pipe; but ultimately the machinery in this mill was transferred to a mill at Pittsburg, and the space vacated was used for additions to the malleable and grey iron departments.

Although the Crane Co. was concentrating upon the manufacture of valves and fittings, the continued growth of the business has demanded extensive additions, particularly since 1890, and this year a five-story modern office building has been erected. Not only has there been an immense increase in the floor space used for manufacturing purposes, but all departments have been equipped with the latest improved machinery, much of which has been designed and built by the company.

The company have at various times manufactured a great variety of machinery and apparatus. As early as 1857, when steam heating was a novelty, they entered this field and next year had a contract for the steam warming of the court house at Chicago. At different times they manufactured heating coils, wrought iron pipe radiators, cast iron radiators, and ventilating fans. Believing that it was not fair for the manufacturer to compete with the trade to which he was selling, they retired in 1874 from the steam warming contract business.

Elevators were made by the Crane Co. in 1867, and the business grew so rapidly that it was soon crowding other work out of the machine shop. In 1870 the manufacture of passenger elevators was commenced. In 1886 the elevator part of the business was separately incorporated as the Crane Elevator Co. and given a complete plant by itself. With a view to concentrating on the valve and fitting business, the Crane Elevator Co. was sold in 1895. While Otis Tuft, of Boston, was the first builder of passenger elevators in this country, and was followed very closely by Otis & Co., of New York, the Crane Co. took up these lines so soon after these firms that the company should be considered as a pioneer in the industry.

About 1865 the company took up the manufacture of pulleys, shafting, steam engines and steam pumps. A Corliss engine built by the company in 1879 was installed in the factory building at No. 10 North Jefferson Street, and has been in continuous hard service from that time to this day. Immediately after the great fire Mr. Crane offered to put several Crane pumps along the river and force the water through the city mains. His offer was accepted, and the water thus pumped was the only fire protection the city had until the city water works was again in operation. At present the Crane Co. does not manufacture machinery for sale, but they have a machine designing department and a machine shop in which is built the special machinery needed in the business.

Some of the important classes of goods put on the market in more recent years have been stationary, marine and locomotive pop safety valves, drainage fittings, extra heavy brass and iron valves and fittings, hydraulic valves and fittings, Ferro steel flanged fittings and valves, ammonia fittings, steam traps, steam and oil separators, malleable and Ferro steel companion flanges, electrically and hydraulically operated and steam actuated valves, and a complete line of flat band fittings.

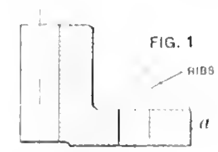
Mr. R. T. Crane, the founder, has been connected with the company since its beginning and is now its president. He has always taken an active interest in economic, political and educational affairs and is a writer upon educational problems. He lays great stress upon the importance of manual training and in 1892 equipped a manual training room in one of the Chicago schools, and employed a teacher for instruction in this department. He later provided the means required to give instruction in manual training in the lower grades of the Chicago schools and gave funds for 24 scholarships. In recognition of his interest in this branch of education, the board of education has recently named a new school the R. T. Crane Manual Training School. An active interest, also, has been taken by Mr. Crane in the welfare of his employees. Prior to the establishment of a pension system by the company he personally pensioned employees whom sickness or old age had rendered helpless, and since 1899 each employee has been presented with five per cent of his earnings of the previous year, on the first of each January, except that last year and the year before, the amount was 10 per cent.

GENERATING A LARGE INDEX PLATE.

A. L. DE LEEUW

Much has been written about methods of generating correct index plates, but the subject is not exhausted by any means, and any new way is almost sure to be of interest to many mechanics. I would not like to take oath that the following is new, neither would I be surprised if I should hear that the Chinese used the same method for spacing the bricks in their great wall; but to me it was new, and I have no doubt it will be to a great many others.

I was up against the problem of cutting some large gear rings, 10, 12 and 14 feet in diameter respectively. They had to be cut very accurately as these gears were to be driven by two pinions, diametrically opposite each other. Such a drive requires much greater accuracy in the gear than where only one pinion drives. The reason is obvious. Take a gear with 176 teeth—every pitch might be 1/1,000 inch too large over the first half of the gear, and 1/1,000 inch too small over the last half; and the error would be so small that there would



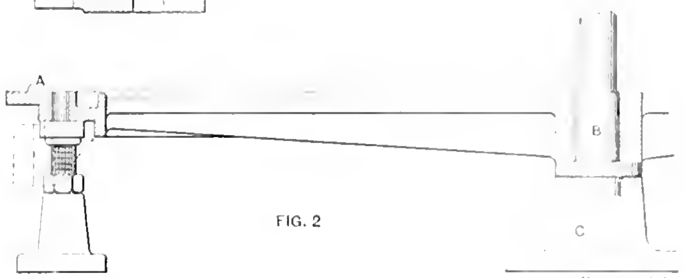


Fig. 1 Section Gear Rim. Fig 2. Half-section of Index Plate

be no appreciable defect in the drive, so long as there is only one pinion. But space No. 89 would be 88/1,000 inch out of place, and, when there are two pinions, it would be this space which would be acted upon by the second pinion, while the first pinion engages space No. 1. Now, 88/1,000 inch is entirely too much of an error to be neglected; in fact, such an error would condemn the whole drive. And yet, the individual error in the spaces would be so small as to make it almost impossible to avoid them. It is this possibility of errors accumulating which makes it so difficult to originate a correct dividing plate.

The gears to be cut were 150, 176, and 210 teeth respectively; 1¼ diametral pitch. They were to be cut on the slotter, as there was no gear cutter large enough to handle such work. The section of the gear was like Fig. 1. The fit was at *a*. A number of bolts were to secure the gear to the table of the boring mill which it was to drive. The ordinary way to cut a gear of this type was to turn it up and fit it to a spider or index plate. The bolt holes in this spider were used as jig holes to drill the holes in the rim of the gear, thus making all gears interchangeable. The spider had notches milled in its outer circumference. This was done on the gear cutter, with the result that if the gear cutter had any errors, those errors would be reproduced in the spider. As a rule, the diameter of the spider was very much larger than the diameter of the dividing wormwheel on the gear cutter, so that the errors of the wormwheel were not only copied, but even enlarged. All this was absolutely inadmissible on this job, so new spiders were made and provided with as many holes as the gear was to have teeth. These holes were all drilled at equal distances from the center, and very accurately spaced; and, *above all*, the spacing and drilling was done in such a manner that the *errors could not accumulate.*

It is generally accepted as true that about the most difficult job in the machine shop is the drilling of a hole in the proper place and of the proper size. It will be easily seen, therefore, how much more difficult it must have been to drill some hundreds of holes, all in their proper places. I think the methods used to accomplish this feat successfully would interest many mechanics, hence this article.

The plate to be divided was first turned true and with a smooth surface, *A*, Fig. 2. It is the under side of the spider but is the side used for dividing. The gear is shown in place, though this was not the case while the spacing was being done. The spider was pivoted on a stud, *B*, held in a stand *C*. The outer rim of the spider was supported by numerous jack screws, with brass caps, allowing the spider to slide over the jacks, but preventing it from sagging. The jackscrews were locked in position, as shown.

On stud *B* two arms were mounted. These arms were about 7 feet 8 inches long from the center of the stud to the outer end. They were made of cast iron, and as light as was consistent with the required stiffness. Both arms would turn around the stud. The bearings on the stud were, of course, one above the other, but the main part of the arms were in the same plane. When in position they formed a pair of large jaws. A hardened steel hook was fitted to the end of each arm, and these hooks coming in contact when the arms were a certain distance apart made this distance the maximum space between them.

Fig. 3 gives a diagrammatic view of the above arrangement. *A* is the plate or spider to be spaced. *B* is the stud around which the arms *C* and *D* turn. *E* and *F* are the hooks or limiting pieces. The arm *C* is provided at its extreme end with a piece holding a hardened steel pin, *G*, rounded at its end. This piece could swivel, so as to allow the pin to point in various directions. When once adjusted, the swiveling piece was clamped in position. The other arm *D* had a similar swiveling piece, which was split and provided with a clamping screw. It was tapped out, and held a micrometer screw, which could be clamped by means of the split bearing and clamping screw. The end of the screw was rounded over, and the head was made large and divided so that one division corresponded to one half thousandth of an inch. No attempt was made to have this screw, or the divisions on the head, very accurate; it was used as it came from the lathe, for as will be seen later on accuracy of this screw would serve no purpose. A pointer was fastened to the swiveling piece. This pointer was simply a piece of sheet steel with beveled edge, and long enough to be always over the screw head. The piece, *G*, and the screw, *H*, were adjusted, so as to be in line when butting up against each

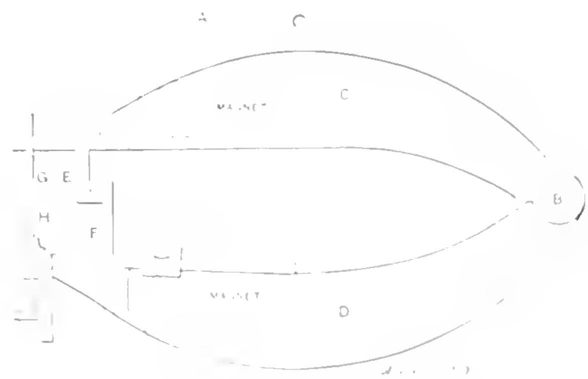


Fig. 3 Plan of Arms which are Mounted on Stud B Fig. 2

other. In this manner the movement of the arms relative to each other was limited both ways one way by the hooks, and the other way by the pieces, *G* and *H*.

The mode of operating was as follows: one arm was pulled back until the arms came in contact, when it was clamped to the spider. Then the other arm was moved up, until the screw *H* struck the pin *G*. This arm was then clamped, and the other released. The first arm was then pulled back again, and these operations were repeated, thus moving both arms all around the spider. The arm *D* was provided with a planed edge, to which a piece, *I*, was securely fastened. This piece is shown in detail in Fig. 5. It consisted of a slide, carrying a jig eye or bush, to be used later on for drilling the holes. It also carried a brass block, *J*, which was carefully scraped to a bearing on the spider. To the block was screwed a glass hard steel piece *K*, with beveled edge, and located about 1/1,000

inch above the spider. This steel piece formed a scratch edge for marking lines on the spider. A line was marked on the spider and the screw set so as to get approximately the correct division. The arms were then brought around as described, and, after the required number of spaces was made, the distance was noticed from the scratch edge to the starting line. This would give some idea as to how much correction was to be made, and the correction was made by means of the micrometer screw.

As stated before, no attempt at accuracy was made. In fact, and this will be clear by this time, the whole method is one of trial. It is the same as spacing with a pair of dividers; but, where dividers fail, this method succeeds. Any one who ever tried to space with dividers knows how impossible it is to get the same result twice. The point slips off in some minute hole of the iron, or the angle at which the dividers are held varies, or some other little thing happens, which makes the result unreliable. If one succeeds in setting the dividers so as to come back to the starting point, say after 176 steps, this same setting will give entirely different results if the same man goes around once more.

The clamping of the arms is accomplished by means of electro-magnets, fastened to the under side of the arms. The magnets were wound so that they would stay cool on a 220-volt circuit, when in series with a 110-volt 16-candle-power lamp. This lamp acted as pilot lamp, indicating when the current was turned on, and also indicating when something was wrong with the winding. And, by the way, this happened a few times; the magnets being home-made affairs. It is obvious that, holding the arms in position by means of magnets,

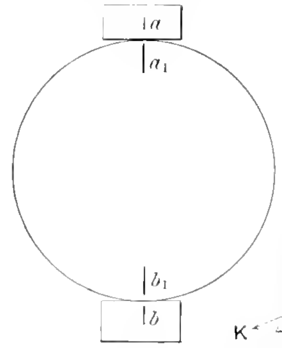


Fig. 4. Diagram showing Method of Halving the Circumference.

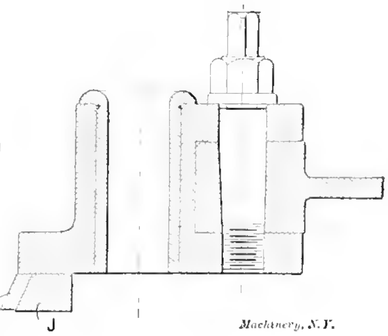


Fig. 5 Slide Carrying Jig Bushing and Scribing Edge.

is far superior to clamping, as the latter method would easily throw them out of square. Even the magnets were liable to cause trouble, as I found to my regret. This trouble did not occur on the job I am describing but on a previous job, when I and every one else engaged on it was as green as a meadow in spring time. If the surface of the plate is not perfectly level, smooth, true, well supported at frequent intervals, and on a rigid foundation, where it is not disturbed by vibrations of nearby machines, and if the magnets are not scraped nicely to a bearing with the plates and also to the arms, and if they are not protected, so that no dirt can creep between them and the plates, and if one of several other things is not provided for, then, well—then there is trouble. And the trouble with this trouble is that it does not show up until one has gone clear around the circle; and even then it may not be immediately discovered. One may find an accumulated error of 1/16 inch after going once around; one may correct for this amount, and, after going around once more, one may find an error in the other direction. Trial after trial may not produce any better result, and one may think that it is simply bad luck in estimating the correction to be made; whereas, in reality it is simply the result of poor working conditions. Great care and an infinite amount of patience are necessary, but with those elements at hand, the method gives fine results.

To start the spacing, two lines diametrically opposite each other were marked on the plate. To get these lines correct the following method was used: Two stations were erected at opposite ends of a diameter of the plate, or at least nearly so. These stations were merely castings blocked up to the proper height, so as to bring their top surfaces level with the top of the plate. A piece of sheet brass was fastened to one of the stations; the other station received an adjustable piece of sheet brass. Lines were drawn on these pieces of brass, so as to be nearly in line with each other and with the center of the spider. This, of course, was merely guesswork. These lines were extended onto the plate, so that the whole thing looked as shown in Fig. 4. The two lines on the brass are marked a and b; and the two extensions of these lines on the plate, a_1 and b_1. The plate was now turned until b_1 came exactly opposite a. Now, if the lines a_1 and b_1 are exactly diametrically opposite each other, then the line a_1 is bound to come exactly opposite the line b. This, of course, was found not to be the case. The distance between a_1 and b was now carefully divided in two equal parts, and a new line, a_1 and b (one an extension of the other) was drawn on the brass and on the plate. Then another half turn was given to the plate, and the line a_1 was brought opposite the line a, and the error (if any) noticed. This was repeated until no further error was discovered. The object of dividing the plate in two equal parts was simply to facilitate the first attempts at spacing as an appreciable error could be discovered by going only half way around. The lines a_1 and b_1 were not used, however, for the final spacing.

The distance was measured from the center of the stud to the center of the micrometer screw. No accuracy was aimed at. Measuring within ⅛ inch was good enough. From this measurement, the circumference of the circle, described by the screw point, was computed. This was divided by say 176, and the quotient was the distance from the point of the hardened plug to the point of the micrometer screw. A pair of inside calipers was used to set the screw to this distance. Then, 88 such distances were spaced, and the result noticed. Suppose the scratch block was ⅜ inch from the line b_1, then an adjustment was made of 1/88 part of ⅜ inches, or about 4¼ thousandths of an inch, which is about 8½ divisions of the micrometer screw head. It would have been a difficult matter to estimate the amount of correction to be made, if not assisted by the micrometer screw. One must not expect to "hit it" the first time, but considering the difficulty of the job it is surprising how few trials are necessary to get perfect spacing. It never took more than one day (of ten hours) to get a perfect spacing, after everything was rigged up. When the scratch block comes to the edge of the first line, after the required number of steps, the spacing is considered finished. It remains, however, to prove that this result was not obtained by some "lucky" mishap, or rather by some hidden defect. For this purpose we would go around once more. If again the scratch block came against the outside edge of the first line, it was considered safe to proceed with the next operation —the drilling of the holes. The first work was to step around again, and to draw a line along the scratch block at every step, thus marking a line for every hole to be drilled. This operation was an additional check on the accuracy of the spacing. There were to be 210 holes in the largest spider. Stepping around three times (once for the last trial, once for checking and once for marking the lines) required 630 spaces. The lines drawn were at the most 2/1,000 inch wide. A magnifying glass was used, to see if the scratch block came up against the line; so that it is safe to say the error was less than 2/1,000 inch. This means that the error in the individual spaces was less than 1/630 part of 2/1,000 inch. This seems too good to be true; but it was done several times in this job, and had been done in 10 circles of holes in a previous job.

One of the two arms was now removed from the spider, the arm with the drill jig remaining. A radial drill had previously been put in place, and the dividing arm was secured against the radial drill column. The spider was rotated under the arm by means of block and tackle, so as to bring the consecutive lines against the scratch block. A magnifying glass was used to locate the spider accurately. The hole was then drilled 1/32 inch small. The holes were to be 1 inch ultimately, so that a 31/32 inch drill was used. The drill was then replaced by a reamer a couple of thousandths below size, and the reaming was done by power. It goes without saying that the drill jig was taken out, and a new one corresponding in size with the reamer was put in place. After this operation was completed, the jig eye was removed once more, and a new one was inserted, having a bore of 1 inch exactly. This jig was used for reaming by hand.

The question will naturally present itself to the reader: Why was the second arm taken away? Why was not the same method used for drilling as was used for spacing? This was done originally, and could be used if it were necessary, but there were two reasons why this was not done. The first one is that, in that case, the spindle of the drill must follow the work, for the arms would take different positions on the spider, and arms and spider would have to be brought back under the drill spindle, or, in case of a radial drill being used, the drill spindle might be brought back over the jig eye. This would mean very careful adjustment, repeated many times. By leaving the drill spindle stationary, and the arm blocked up against the column, the relative adjustment of drill spindle and jig eye is preserved. The second consideration is of an entirely different nature. Electro-magnets were used for the purpose of holding the arms in place. This proved to be an excellent method; in fact, it would have been absolutely impossible to hold the arms without springing, and with uniform pressure by other means. But, when drilling, chips would crowd themselves between the magnet and the spider, in spite of all precautions, even though the plate was cleaned after drilling a hole. These little chips, perhaps too small to be seen, would tilt the arm forward, and crowd the drill. For these reasons, magnetism was not admitted while drilling, the clamping being done by an ordinary C-clamp. It is true that the setting of the arm was not so perfect as when done by means of the spacing method, but it was good enough for the purpose, for it must not be forgotten that it was not the object to get a gear with absolutely even pitches, but one with reasonably correct pitches, and where the errors *would not accumulate*. This latter requirement was taken care of by the method of spacing, and a good mechanic can set an edge so close to a fine line that the error is not appreciable in a gear of 1¼ diametral pitch. A good device for protecting a magnet from chips, however, is shown in Fig. 6.

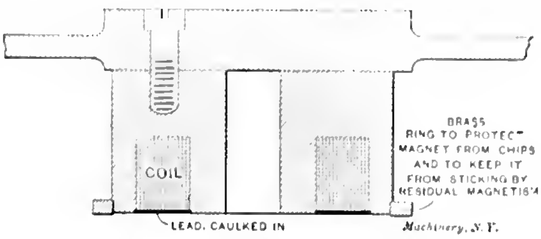


Fig. 6. Cross-section of Magnet.

The above work was done under my instructions, but credit is due to Mr. Julius Kreis, a designer of The Niles Tool Works, who made the drawings and personally supervised the work, and to Mr. Henry Moser, machinist at the above works, who brought the work to a successful end.

It may be of some interest to know something about how the gear was actually cut. This was done on a slotter, specially designed and used for similar purposes. The Niles Tool Works Company keep two of these slotters busy practically all the time. They are used for all internal gears, and for external gears which are too large in diameter, or of too heavy a pitch to be cut on an ordinary gear cutter. The table is very long and in the shape of a cross, thus giving a large surface for the support of the spiders, without making the table too heavy. For unusually large gears additional supports are provided, in the nature of stands placed around the machine, each on its own foundation. A T-slot runs the long way of the table and exactly in line with the center line of the ram. A stud and bush, held in this T-slot, serve as pivot for the spiders. The lower end of the ram has a square hole to take the tools, which are placed in horizontal position. Fig. 8 is a sketch of such a tool. The shank of the tool is planed to a gage, so that the center line of the tool has always the same distance from the planed side of the shank. Inserting the tool in the square hole, and forcing it up by means of setscrews against one side of this hole, brings the center line of the tool in line with the center line of the machine, and thus with the center line of the gear to be cut. The gear blank is fed toward the tool until within one or two hundredths of an inch of the required depth, when the power feed is thrown out, and the blank is further fed by hand. A stop prevents the operator from making a mistake as to depth. In addition, several other precautions are taken. The pitch line, and the bottom line of the teeth are marked on the blank by means of a scratch gage, shown in Fig. 7. In case the teeth are blocked out in the casting (for the purpose of securing a better casting, at least around the teeth) the operator first goes once around, outlining the tooth shape on the blank, to make sure that there is sufficient stock for every tooth. In order to do this outlining he brings the tool down to within 1/32 inch from the blank, and marks around it with a scratch awl. A screw is used to move the blank when it is unusually heavy. Otherwise this spacing is done by hand. The notches, milled in the outer rim of the ordinary spiders, are engaged by a stop pin, which indexes the gear. In the case of our gears, however, holes were used and a pin located under the spider, and held by a suitable bracket. The pin was withdrawn by means of a lever.

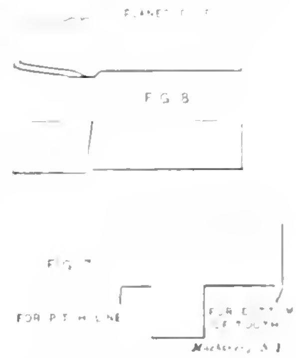


Fig. 8. Gear Tooth Tool for use in Slotter. Fig. 7. Gear Tooth Gage.

The gears proved to be excellently spaced, and the two driving pinions showed a perfect bearing on the gear teeth. Though the side clearance in the teeth was only 1/100 inch such a thing as a bearing on the back of a tooth never occurred.

* * *

AN INTERESTING GRINDING OPERATION.

The George Gorton Machine Co., Racine, Wis., build an engraving machine in which half-round pointed cutters, revolving at high speed, are employed to execute the design, being guided by a pantagraph which reduces the copy to the desired proportion. The copy to be duplicated is held in a copyholder, and by means of the pantagraph the operator accurately duplicates it by tracing its outline with the pointer at the long end of the arm. In order to produce an engraving that shall be smooth and free from ragged lines, the highest order of workmanship is required in the construction of the pantagraph and the cutter spindle. The joints of the pantagraph must work with the utmost freedom, yet be very closely fitted, hence they are made with ball bearings. As the spindle is required to run at very high speed, it must be perfectly balanced and well lubricated to prevent heating. Moreover, perfect balance is required to avoid vibration which would be destructive to good work. Fig. 1 shows the vertical cross-section of the cutter spindle and the sleeve in which it runs and Fig. 2 shows the spindle twice the full size, with the working dimensions and other details. After the spindles are turned and bored on the lathe, they are hardened and ground on a Landis grinder, and then lapped to a nicety. The grinding operation is one of considerable difficulty because of the extreme accuracy required in the concentricity of the taper bore for the cutter shanks and the external bearings. At our request the operator of the grinding machine, Mr. Philip Korzilius, has kindly described for us the steps followed to produce accurate spindles.

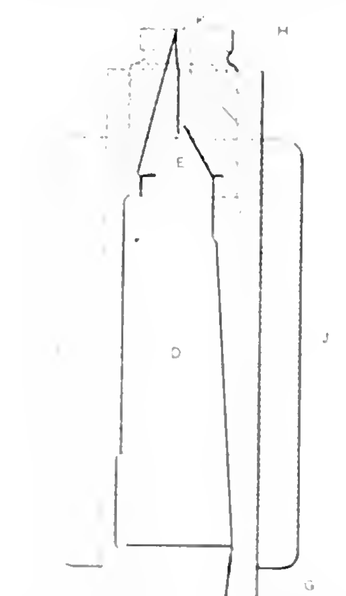


Fig. 1. Section through Spindle Bearing of Engraving Machine.

The hardened spindle is first mounted on a plug fitting the

taper holder in the grinder spindle and the grinder head is set to an angle of 30 degrees in order to rough-grind the 60-degree thrust bearing *E*. Then, without moving the work, the tailstock is run up with a female center to fit the 60-degree point just ground. The grinder head is swung back to zero and the grinder bed is set to a taper of ⅝ inch to the foot to grind the spindle at *D* for a future operation.

various grinding operations outlined in the foregoing follow progressively as each operation on the lot is completed.

The sleeve in which the spindle runs is also made of tool steel hardened and accurately ground for the lower bearing taper; also for the upper thrust bearing, and on the outside. The upper thrust bearing is merely dropped into position, being pushed down very lightly against the 60-degree thrust

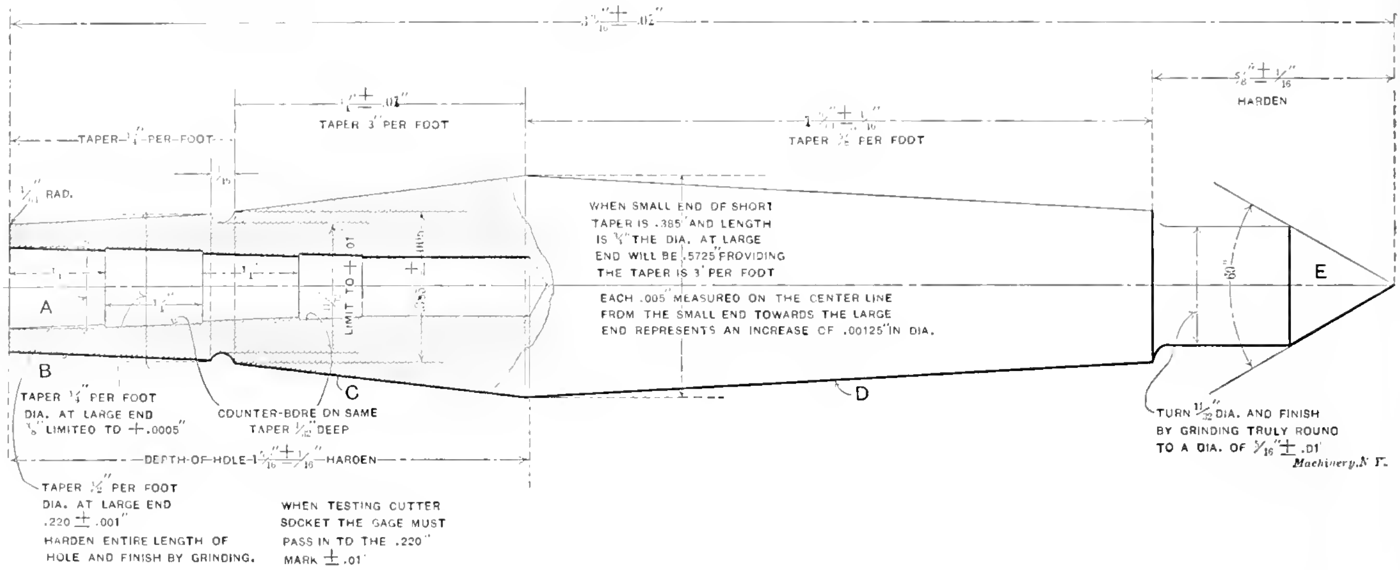


Fig. 2. Enlarged View of Spindle.

The second operation consists of three steps: The work, which now has been ground to a ⅝-inch taper, is placed in the taper hole in the grinder spindle, and the first step consists in rough grinding and finish grinding the pulley taper *B* at cutter end of spindle; which is done with the bed set to a taper of ¼-inch per foot. The second step of the operation consists of rough grinding the lower bearing *C* just above the pulley taper. This is done with the grinder bed set to a taper of 3 inches per foot. The third step consists of the rough and finish grinding of the internal taper *A* for the cutter shanks, and this is done with the grinder bed set to a taper of ½ inch per foot. It will be noticed that the taper hole is counterbored on the lathe to form clearances for the grinding operation.

The taper hole for the cutter shanks having been finished, the third operation is the same as the first operation, the work being mounted on a plug in the grinder spindle in order to finish grind the 60-degree thrust bearing *E*, which was rough ground in the first operation. In this case, as before, the bed is set at zero and the head at an angle of 30 degrees. After finish grinding, the head is swung back to zero and the female

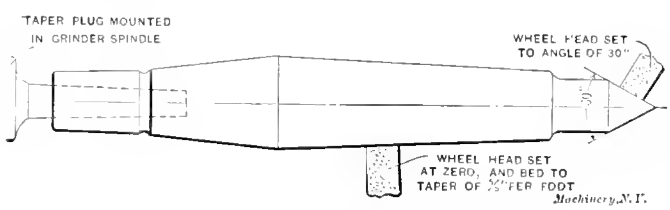


Fig. 3. Method of Grinding Upper End of Spindle, first and third Operations.

center in the tailstock is run up to support the 60-degree point, and the parallel portion immediately below the taper is then ground, but the size is not material as this portion is not fitted to any other part. With the female center still in place, the bed is swung to a taper of 3 inches per foot, and then the lower bearing *C* is finish ground which was rough ground in the second step of the second operation. This brings both bearings, lower *C* and upper 60-degree thrust *E*, true with each other and concentric with the internal taper.

All sizes are tested and maintained by special working gages which in turn are tested periodically with master gages. The great difficulty in obtaining an accurately finished cutter spindle of the dimensions shown in the drawings, is caused by a comparatively small diameter of the taper hole for the cutters. Of course, the spindles are made in lots, and the

bearing on the cutter spindle and the barrel, being split at this end, is clamped over the thrust bearing, thus holding it in the desired adjustment. This construction of spindle and sleeve

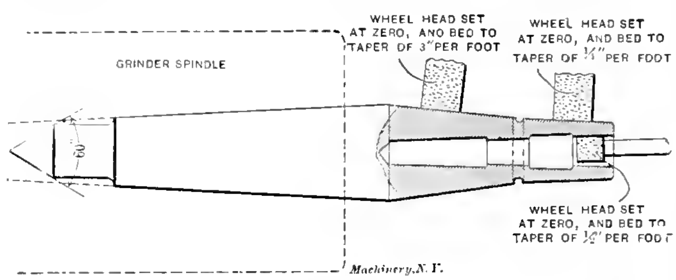


Fig. 4. Method of Grinding Lower End of Spindle, second Operation.

makes the removal of the spindle from the barrel for cleaning a very simple operation. The makers say that it can be removed, cleaned and reassembled accurately in one minute.

* * *

TESTS OF HELICAL SPRINGS.

The Watertown Arsenal has made quite extensive tests of helical springs used in gun carriages. A spring having a free height of 28.3 inches, exterior diameter 7.61 inches, diameter wire 1.25 inch, distance between coils 0.95 inch, weight 93 pounds, was compressed to 23 1-18 inches when loaded with 5,290 pounds. A load of 11,800 pounds compressed the spring practically solid, in which condition it measured 16.82 inches high. A spring 21.4 inches high, exterior diameter 4.2 inches, diameter wire 1 inch, distance between the coils 0.28 inch, weight 27½ pounds, was compressed to 19⅜ inches with a load of 4,400 pounds, and was compressed practically solid (height of 17.06 inches) under a load of 9,300 pounds. Sixty springs for 7-inch mortar carriages were tested. The height of these springs was 18.8 inches, exterior diameter 5.08 inches, diameter wire 0.70 inch, distance between coils 0.86 inch, weight 18¾ pounds. A load of 1,250 pounds compressed a spring to 15 inches, and 2,920 pounds compressed it to a height of 9½ inches. When closed down solid the height was 9.08 inches and the load was 3,500 pounds. Twenty of these springs were closed down to a height of 9½ inches for a period of 64 hours, and immediately after their release the free heights were measured and again later after remaining unloaded 48 hours. The average decrease in free height was 0.19 inch immediately after release, and after 48 hours it was 0.14 inch. In other words, the springs recovered 0.05 inch of the set.

WHY STEEL CAN BE CUT FASTER THAN CAST IRON.

In a paper, "High Speed Tool Steels," read by Mr. Arthur B. Corby before the Salford Science Students' Association, April 8, 1905, the author very clearly told why steel can be cut faster than cast iron: "With all the tool steels working on steel at high speeds the continual rubbing of the shaving on the upper surface of the tool wears more or less of a pit on the surface. At the same time, on the extreme point of the tool a small accumulation of portions of the material being cut gathers, being practically welded to the tool. Now, the position of the pit on the upper surface of the tool is situated further back from the cutting edge with a deep cut than with a light one. This is owing to the tenacity of the steel, and is not found to be the case in turning cast iron. The tenacity of the shaving and the action of the tool as a wedge cause the actual point of cleavage to be in advance of the extreme edge of the tool. The larger the chip, the greater its strength is, and therefore the further back on the tool it slides, making a greater angle between the shaving and the work wherein the front of the tool is more or less clear. The tool splits off the shaving of material like an axe cleaving wood with the grain. After having once entered, the cutting edge of the axe is clear, while the thicker part of the axe, acting like a wedge, forces the wood apart. In my opinion, the action of the tool in cutting steel is similar, and with the larger cuts the greater part of the work is done well back on the tool, where there is a good body of steel. In a lighter cut the shaving wears a pit right up to the cutting edge, thereby weakening it, and causing it to break down sooner. With cast iron, owing to its brittleness, the action is different, and the work is practically all concentrated on the cutting edge. When the tool first penetrates a piece of iron is broken off for a little distance in advance of the tool; the roughness intervening is removed as the work revolves against the tool, the point of which again penetrates and breaks off a portion, and so the action continues."

TRAVELING JIB CRANE AND TRAVELING JIB DRILL.

The large erecting floor shown in Fig. 1 is that of the Bucyrus Company of South Milwaukee, Wis. This concern which normally employs something over 800 men, builds steam shovels, hydraulic dredges and locomotive cranes and it is here that the 94-ton Bucyrus steam shovels which are now being used in digging the Panama Canal were constructed. In building steam shovels the frames are erected on the trucks and the superstructure follows, the work being conducted in substantially the same manner as cars or other rolling stock are built. A great deal of drilling has to be done as the erection proceeds, and for this work the traveling jib drill shown in the half-tone, Fig. 2, and in the line cut, Fig. 3, is employed. The general view of the erecting floor, Fig. 1, however, does not include it. This machine has a radial arm about 11 feet long, which, with the available longitudinal movement, enables the drill spindle to be used for drilling vertical holes on any part of the steam shovel in construction. As is evident from an inspection of Fig. 2, the drill spindle is operated by an electric motor mounted on the radial arm; the panel for the starting box is fastened to the side of the arm, in which position it is convenient for the operator. The armature shaft is geared to an intermediate shaft on which are mounted the back gears at the left of the controller for changing the speed. The feed mechanism is extremely simple, the rate of feed depending entirely on the weight and disposition of the man at the end of the lever arm!

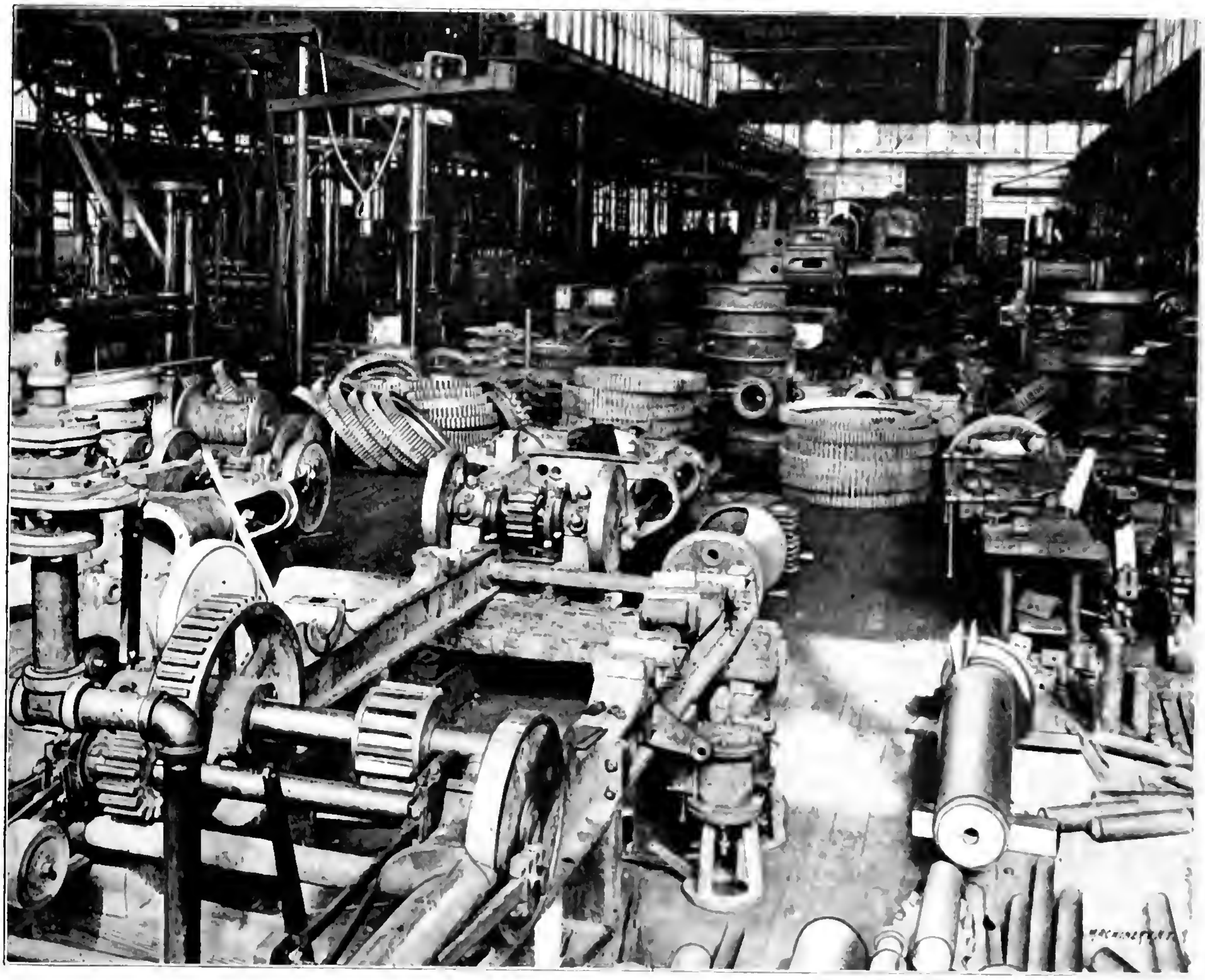


Fig. 1. Erecting Floor of the Bucyrus Company's Shops, showing Typical Dredge Work in Process of Erection.

Behind the traveling jib drill is another track, shown in Fig. 3, on which is operated a traveling jib crane of 7,000 pounds capacity for handling plates. This crane is mostly used in the plate shop but may be employed for transporting material from the plate shop to the storage yard when occasion requires. It is shown in the half-tone, Fig. 4, and the line cut, Fig. 5, which gives the principal dimensions and the

arrangement of the operating machinery. This type of crane is one that can be very profitably employed in many shops that are now struggling along with inadequate handling facilities because the managers are, perhaps, under the impression that the traveling crane is the only satisfactory means that can be installed to meet their requirements. But in shops of old construction not designed for supporting heavy weights, the roofs are generally too weak or not properly constructed for installation of the traveling crane, and the Bucyrus plate shop is an example. The walking crane, however, "fills the bill" to perfection and imposes no severe stresses on the roof trusses. As is quite evident, only a single track is required to support the weight of the crane, and the top support is taken from the girder at the side. The top support, shown in the half-tones, is the lower part of the traveling crane track, but in the plate shop it is the side of the clear-story. The frame of the walking crane is narrow, so that a clear space of only about three feet wide is necessary for its passage. The swinging arm covers the full width of the middle bay of the plate shop, which enables the operator to pick up work in any part of the floor and transport it to any other place within range of the arm. The operator's stand, it will be noted, is shown at the left in Fig. 4, a low platform being constructed for the purpose, where he has the controller and brake at hand, and a clear view of the floor and the work to be picked up. An objection that might be raised to the use of the walking jib crane is the apparent danger of the workmen being caught and crushed by the wheels. But this is largely imaginary, for simple guards in front of the wheels push anything out of the way; and it is said that during the years it has been used in the Bucyrus shops not a single accident has occurred from its use.

A large part of the work seen in the erecting floor view, Fig. 1, is for hydraulic dredges of the type which is being largely used in the West for placer mining. Some of these dredges, such as are now in use near Oroville, California, are of enormous size and power; for example, the largest size built has 60 buckets on the chain, each bucket holding 13 cubic feet. The drums over which the chain is wound are

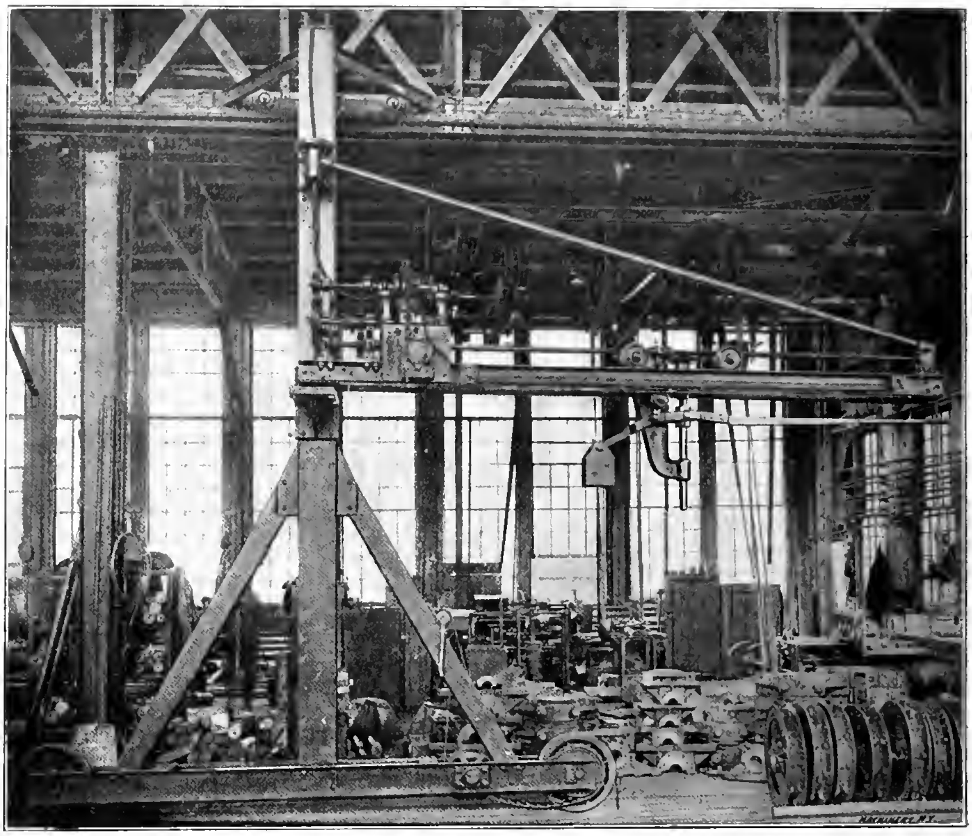


Fig. 2. Traveling Jib Drill.

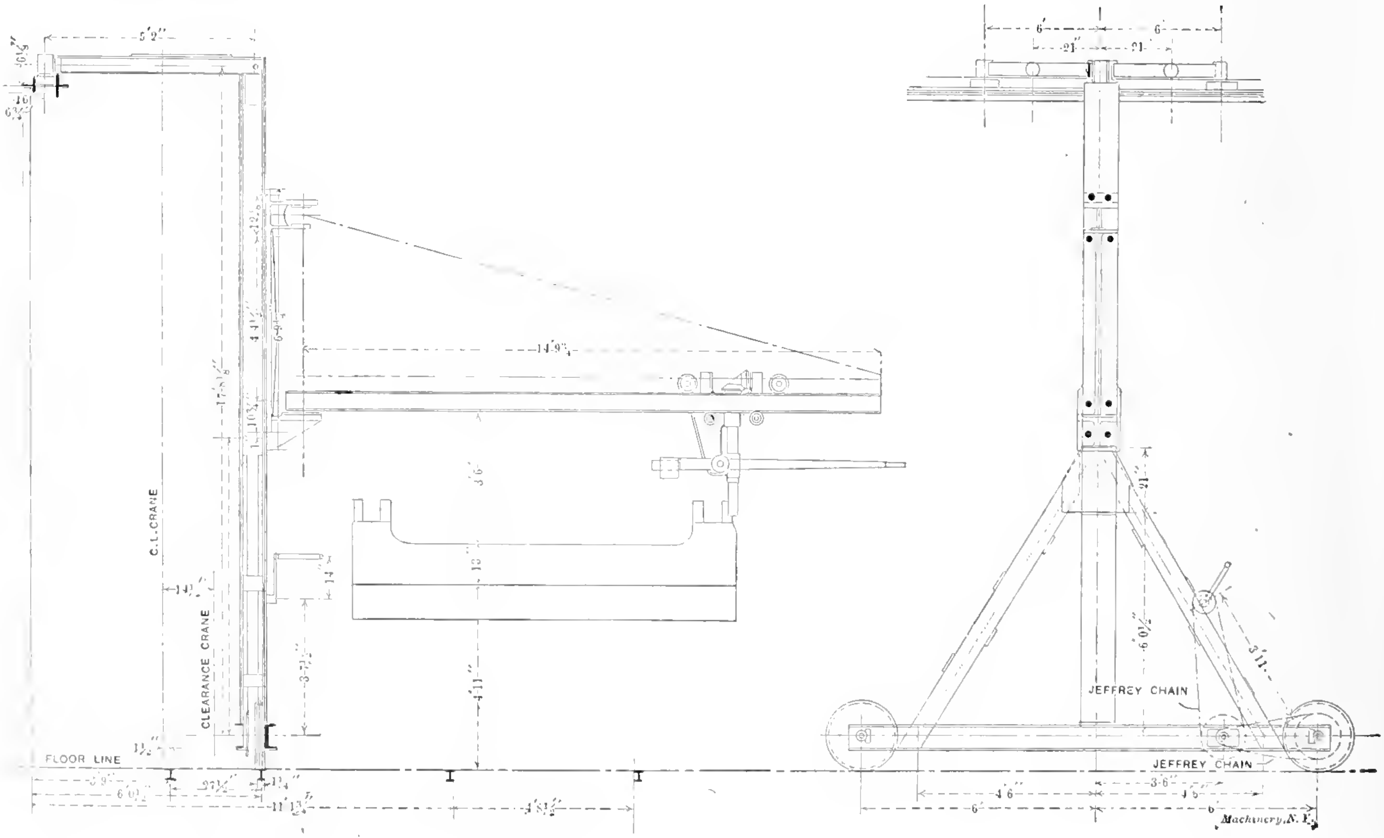


Fig. 3. General Dimensions of Traveling Jib Drill.

huge hexagonal steel castings with grooves to engage lugs on the chain. The steel casting which forms the link and foundation for the bucket weighs something over 3,500 pounds each. The lips of the buckets are made of manganese steel and the pin holes in the links are fitted on one side with a half-bushing of manganese steel. The manganese parts are very hard and tough and all holes must be cast exactly where wanted, as it is impossible to drill or machine them in any other way but grinding. The gears shown in the general view are used in the operating machinery of the dredges, one large spur gear being mounted on the shaft with the hexagonal winding drum. In the largest type of hydraulic dredge this gear is about 14 feet diameter. It is made with a steel rim and hub and cast-iron spider.

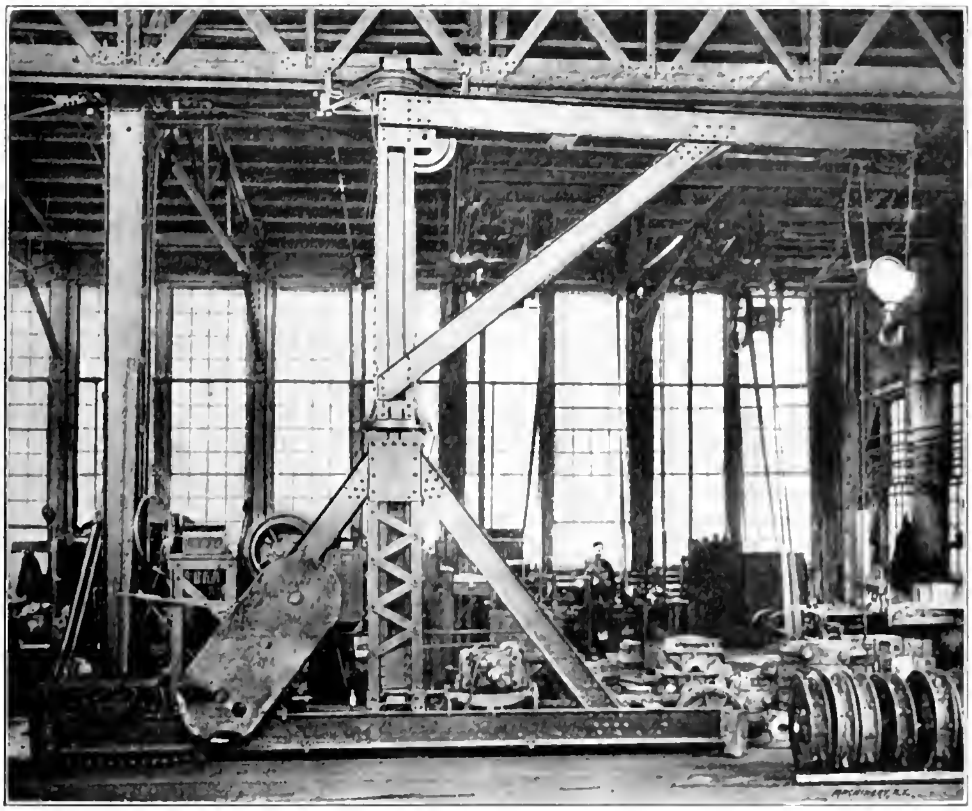


Fig. 4. Traveling Jib Crane.

SOLDERING ALUMINUM PATTERNS.*

The objection most often heard to aluminum as a pattern metal is that "it can't be soldered," or that "it is extremely difficult to solder," or that "a good joint can't be soldered." Now it is proverbially hard to prove a negative, and it is especially true in this case. The chief difficulty in soldering aluminum lies in not knowing how. It is not generally known that a fair job of soldering can be done upon aluminum with common half-and-half solder, but such is the case. We have patterns which have been in use a long time upon which are shrinkage holes soldered with the common solder. It is only necessary to follow the directions given below for using aluminum soldering, using no flux. Also, aluminum with 10 per cent. tin added will solder better with common solder. However, a special aluminum solder is much better, making a stronger job and being easier to use. We have been experimenting and testing aluminum solders for several years, and have found the one below is best, considered from all points, for metal pattern work. It is slightly different in color from aluminum, which makes it useless for ornamental work, but it is cheap, easy to use, and very strong and durable. We have made test joints with it which have stood more strain than the aluminum itself, the casting breaking at one side of the joint, though, of course, this is not usually the case. The recipe for this solder is as follows, all parts to be measured by weight: Aluminum, 1 part; phosphor-tin, 1 part; zinc, 11 parts; tin, 29 parts.

In making this solder, melt the aluminum first. Then add the zinc in small pieces, so as not to solidify the already melted aluminum. Then add the tin, taking the same precaution

* Extract from article, "Aluminum as a Pattern Metal," by H. N. Tuttle in *The Foundry*, June, 1905.

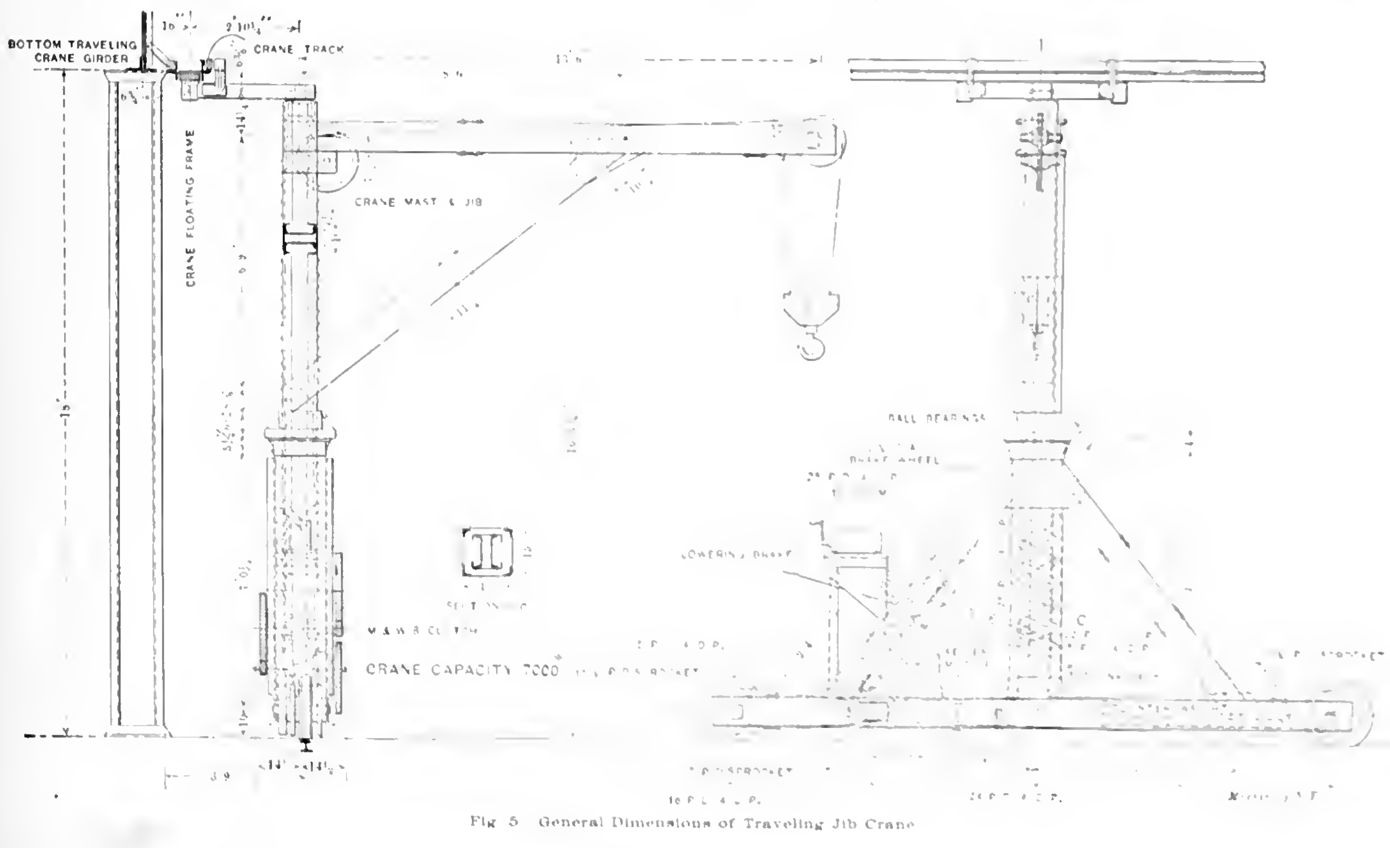


Fig. 5. General Dimensions of Traveling Jib Crane.

not to solidify the metal, and lastly, drop in the phosphor-tin, stir well with a brass rod, and quickly pour into molds, which may be easily made in the open sand. Use a crucible in making this solder.

The reason for observing the above order of melting is that if the metal with the lower fusion point were melted first, and then brought up to the temperature necessary to melt the aluminum, the lower metal would be over-heated and partially vaporized, thus destroying the proper proportion.

In regard to using the solder, it is well to understand a few points about aluminum oxide. This oxide is a thin film or skin which forms upon the surface of aluminum immediately upon its coming in contact with the air. This oxide forms practically instantaneously, so that if a scraper or other instrument be pushed across the surface of the metal, the oxide forms before the bare metal comes in sight. It also forms upon the molten metal, and it sometimes happens in pouring, that the workman finds he is pouring his metal through a tube of oxide. It also sometimes happens that when he overfills his flask, and the metal runs over the side, in the case of heavy casting, a film will form around the overflow, and siphon quite an amount of metal from his sprue, unless he prevents it by breaking the skin.

The oxide is very durable and impervious, so that it prevents the air from reaching the inner metal, and thus further oxidation is very slow. In the case of iron, the oxide is, we might say, very porous, so that the first thin layer of oxide has little effect in reducing further oxidation. Now solder will not adhere to any metal covered with oxide. In the case of brass, the oxide is removed by the flux, but there has been no flux discovered which will remove or dissolve aluminum oxide. However, the difficulty is overcome in a very simple way. The soldering copper, which should be a rather heavy one, and untinned, is heated to a dull redness, and then rubbed back and forth upon the surface to be soldered, melting the solder upon the hot copper at the same time. The surface becomes covered with the melted solder, which excludes the air and prevents further oxidation, while the point of the copper scratches off the oxide already there. Under these conditions the solder readily adheres to the aluminum, and the surface becomes "tinned." For filling shrinkage holes, or building up additions upon patterns, all that is necessary now, is to melt in the required amount of solder.

In case it is desired to solder two pieces of aluminum together, both surfaces should be "tinned," the pieces brought into position and the joint heated with a copper or blow-torch until the solder is liquid, then pressed into place and allowed to cool. Brass must be heated to 460 degrees before solder will adhere to it, while aluminum must be heated about 200 degrees higher, so it will necessarily be a little harder to solder aluminum than brass.

There is a certain stage during the cooling, just before solidification, when the solder may be worked into any shape, at will, like snow, when it is right for packing, or like the amalgam used by dentists. Of course this temperature is hard to maintain, but the temperature at which aluminum "tins" nicely, is nearly at the "wiping" temperature, as a plumber would say, and on this account there is time enough to "strike off" surplus solder, in simple cases.

As an example, suppose it is desired to "build up" a certain surface of a pattern, one-half inch. First "tin" the surface to be "built up." Then place a wooden frame around that part of the pattern, so that its upper edge is in line with the desired finished surface. Then melt in with the copper, enough aluminum solder to fill the frame "heaping full." After rubbing the copper over the bottom and around the corners, to be certain that the solder is melted into the "tinned" surface below, when the solder cools to just the right temperature, "strike off" by "patting" with a block of wood, using the top of the wooden frame as a guide. Sometimes the "striking off" can be better done with a piece of smooth steel, like a scraper.

Fillets may be "wiped" in corners with a common waxing iron with nearly as much ease as wax fillets. The corner, after being "tinned," has a little solder run in, and immediately followed by the waxing iron, which if done at the proper moment, presses the solder into shape, leaving it as smooth as glass, and requiring no further finishing.

Sometimes additions may be more easily cast on than soldered and swept off. In this case the addition may be put upon the pattern in wood, wax, or in any convenient way and the pattern rammed up. After the pattern is drawn and the addition removed, the proper surface is tinned and the pattern replaced in the mold. After the mold is closed the addition is cast on by pouring in melted aluminum solder at a high temperature. Gates which have been broken off are sometimes replaced in this way.

* * *

SOME SIMPLE RED TAPE.

E. H. FISH.

Some time ago I was forced by circumstances to attempt to do about three men's work at the head of a small machine shop, covering a range from office boy to manager, by way of draftsman aud superintendent. Some of the red tape with which I tied things up by way of lessening my own work may interest others who have to make every minute count.

I found at the start that the patterns had a systematic arrangement only in the head of a certain helper and that he was drawing about $150.00 extra a year for this knowledge. At 5 per cent. this made his system worth $3,000, which seemed a little high.

I found that we were building seven sizes of one machine, each designed with very little regard to the others. I began with this machine, and I assigned two hundred numbers to each size when one hundred would have covered the number of patterns for each at the start. Each piece was assigned a number from one up and the second size had this number with a two before it, and so on. That is, if the leg on the smallest size was numbered 56, then the leg on the next size would be No. 256, on the next No. 456, and so on.

This pattern list was blue-printed and a copy of it sent to the foundry, another copy to the machine shop foreman and another used by the pattern-maker and myself. On all drawings the numbers of the patterns were printed in red ink right on the part itself, often across the cross-sectioning. Red ink gives a line on a blueprint of such different character from black that we never experienced any trouble in picking out these numbers and distinguishing them from the dimension figures.

All patterns were stamped with their numbers with broad-faced stamps as carefully as possible, to get the numbers where the patternmakers would not slick them out. If a pattern was found to be used for two sizes of the machine, it was numbered at random with either size, as it happened, and the same number put on the pattern list under both sizes.

LATHE.	No. Pat.	No. on Hand.	No. to Get.	Pat. Found.	Ord.	Cast. Come.
Head	936	2	4	V	2/12	2 + 1
" Shoe	937	0	6	V	2/12	1 + 2 + 3 –
L. Face Plate	938	1	5	V	2/12	1 + 1
S. " "	939	2	4	V	2/12	2 + 2 –
T.G. " "						
" Ring						
Ex. Face Plate						
Face Gear	942	0	6			
Lock Nut						
Cone	944	0	6			1 +
Cone Gear.	945	2	4	V	2/16	
F. Cap						
B. "						
F. Box						
B "						

Fig. 1. Blank used in Keeping Track of Castings in Foundry.

For example, if in a pattern list I found numbers as follows: 423, 424, 625, 426, etc., I would know that No. 625 was used on this machine and on the next larger size and that the pattern was to be found with those of the next larger size.

After the patterns were numbered, they were arranged each size by itself on the foundry shelves, and signs put up showing the size of the machine and the numbers between which the

patterns ran. It was easy after that to order castings over the telephone by number and be sure of getting what we wanted, and we could also be pretty sure that patterns would be returned to their proper shelves.

To keep track of the number of parts running through the foundry, we used the form shown in Fig. 1, this being printed on long strips and cut up to suit our convenience. This has a column in which to place the pattern number. Then a column for the number on hand, which should show from the previous list used for the same size machine, but which we always verified by actual count, including finished or partly finished work. Knowing the number wanted for a lot gave us the number to get, placed in the third column. When running through lots smaller than a dozen, we usually ordered in all the small parts for a dozen and ran them through together, keeping them over the next lot. Then checking off under the column marked "Pat. found," indicated that the pattern was at the foundry. A date mark under "Ord." showed that it was ordered.

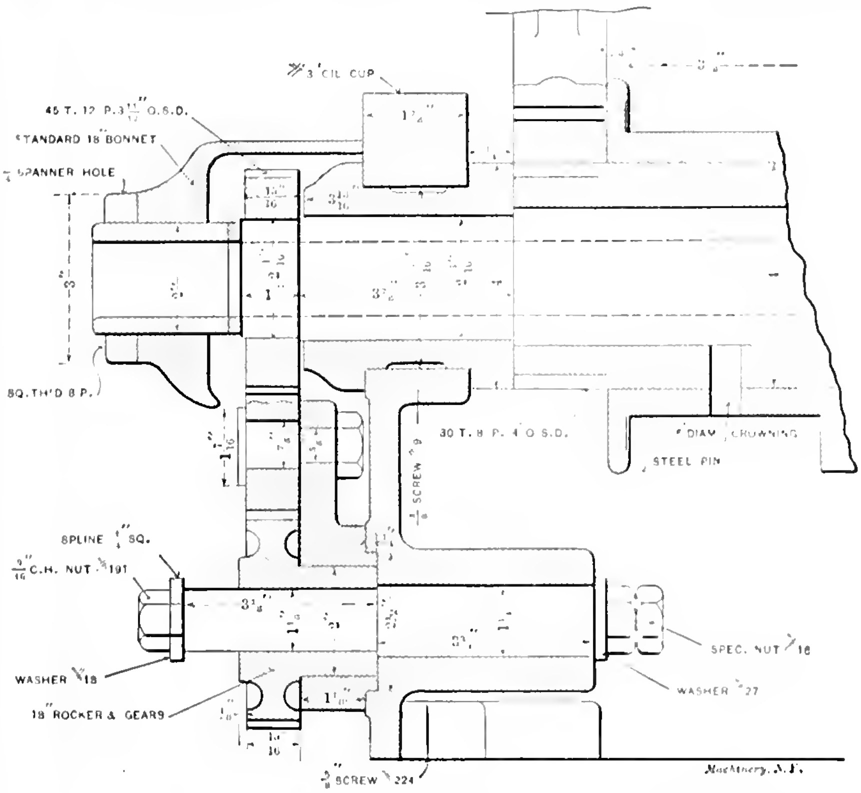


Fig. 2. Part of a General Drawing showing large number of Dimensions used.

As fast as castings came in, we checked them off in the last column. Whenever we went to the foundry, we took these lists along and "punched" them up to get out the missing parts.

This system enabled us to counteract two evils. Where a surplus supply of castings is readily available, and especially in a small shop where no rough store room is maintained, if a workman makes a mistake and spoils a piece, he is apt to throw it away and put another one through without letting the foreman know of it.

It is my opinion that it is cheaper in the long run to let spoiled work drop out of the lot as it goes along and have some all-around man make up missing parts, if necessary, one at a time. Usually we had a supply of all small parts, which are the only ones often spoiled, on hand all finished, but we found it very expensive to let a half-machinist try to make parts to replace spoiled ones as he went along.

The other evil referred to above is the over-making of easy castings in the foundry. An order for a dozen castings in the average foundry means the receipt of from ten to fifteen castings, according to the ease with which they are made relative to their weight.

When they knew in this way that we kept track of what they were doing and occasionally had a few come back, they kept within bounds in good shape. Such an accumulation of parts might do no harm if we never changed patterns, but where time is apt to change anything, it is not well to have much surplus stock coming in without our knowledge.

The next thing to claim attention was the drawings. What we had were only fit for use as amended. The amendments were in a former foreman's head, and therefore unavailable. A set of drawings for each size had to be gotten out in a rush. There was no time to think of detail drawings except where absolutely necessary. This settled down to a set of spindle forging drawings and some pieces that were to be made outside. This, at the time, was a matter of necessity. Now if I had it to do over again, I should do the same thing no matter how much time I had at my command. Detail drawings are unsatisfactory to both workman and foreman until they become familiar enough with the machine being built, so that they know just where every piece goes and how it must be fitted together. To my mind, detail drawings and jigs go together and neither should be gotten out till the machine is a standard article to be made in large numbers.

So I made general drawings, using cross-sections very freely and a liberal supply of dimensions. I remember one 17-inch by 22-inch drawing with over 250 dimensions on it. Drilled holes and tapped holes were indicated by a center line, the size, and where necessary, the depth being indicated on a line drawn off at any convenient angle. Bolts, screws, nuts, washers, etc., were indicated in this way also. (See Fig. 2.) Keys, threads in section, pins, etc., were shown the same way. No pitches of threads were shown except for special taps, as nothing but U. S. S. taps were allowed where they could be used.

The reference numbers on Fig. 2 refer to a bolt list shown in Fig. 3. This list covers all small parts kept in the tool room. In this bolt list only those parts which were special were drawn out. All others had their commercial designation only.

Any reference on a drawing referring to "$\frac{5}{8}$ screw No. 19," called for the screw there shown. The size was given on the drawing so that it was unnecessary for the workmen to get a sample screw before drilling and tapping the hole for it. Screws were only taken from the tool room by men who were putting things together.

One set of blue prints from this list was given to the screw shop where we got our work done, and a set kept in the tool room.

Handles, hand cranks and hand wheels were next attended to. A little study showed that we could get along with about

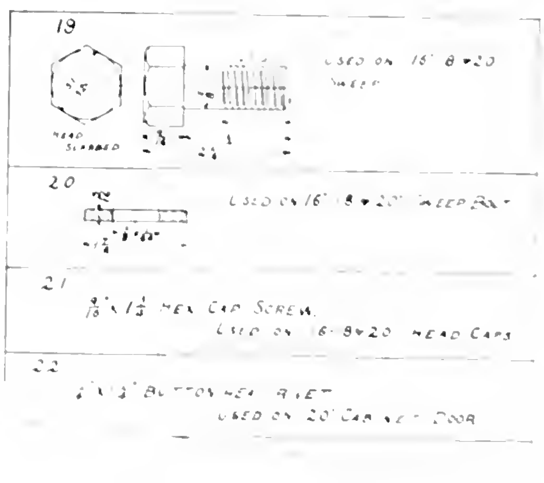


Fig. 3. Section of Bolt List

half the number of different sizes that had been used. Those that we could not dispense with were drawn out as a regular drawing by themselves and numbered 1H, 2H, etc., at random. Reference to these numbers was all that was necessary on the drawings of the machines. Woodruff keys were used wherever possible and designated only by number. As we used only

three sizes, the men came to know their widths and could slot the pulleys or gears without looking them up. Ordinary straight keys were all square and were indicated by simply printing their size where it would readily show on the drawing. Keys with a tit on the end to keep them from having an end motion we found it better to draw out in full.

A cutting off list completed the regular drawings. This list gave the names of pieces and had a series of columns, one for each size machine, in which were given the diameter and length of stock wanted for each piece. Stock was furnished the men all cut to length and they had usually both the drawings and the pieces into which their work was to fit.

A list of the reamers and taps which we had in the tool room was always at my elbow and was constantly consulted to see that we could build whatever was designed. Drawings were all numbered in consecutive order for each size of sheet. As we only used two sizes, 17 x 22 and 11 x 17 (very few of the latter), no difficulty was experienced in distinguishing them without numbering or lettering the sizes. Everything was card indexed under its title and the cards were arranged, each size machine by itself. The parts of the machine were kept roughly in order from one end of the machine to the other. The foreman had a complete set of blue prints and a duplicate card index.

As drawings became obsolete, they were marked so and new drawings indexed. The foreman's discarded blue prints were taken away from him and his index card for that sheet also removed so that the foreman had only live drawings.

Patterns and drawings for odds and ends of jobs were only kept so long as we were sure there would be use for them. Special patterns were made over as often as there was a change and much work was done from freehand ink sketches. Attachments for standard machines were treated, however, as permanent work and were usually needed later.

REPAIRING A 400-TON HYDRAULIC PRESS.

FRANK M. DAVIS.

During the nine years I was assistant shop superintendent at the E. P. Allis works we had many interesting problems to solve in order to do the different jobs that came along. One which I think would interest your readers was the repair of a 400-ton hydraulic press, and I think that, in a certain sense, the circumstances connected therewith are as interesting as the repair:

The Carnegie Steel Company had a repair job in the shop in the shape of parts belonging to a large blooming engine. The old engine was running, and, although the parts showed some signs of giving out, there seemed to be no urgent need of the new ones. The new parts could not be finished until some details were received from the Carnegie Company; but we had started the job in the shop and were progressing nicely when the Allis Company received a telegram that the blooming engine had broken down and that the Carnegie Company must have the repairs at the earliest possible date. The repair parts consisted of large steel gears about 7 feet in diameter and about 3 feet face, the rims of which were cast steel and were shrunk on to cast steel centers. The gears were pressed upon two shafts 28 inches in diameter, one of which was the engine shaft and the other the jack-shaft.

Mr. Church, the shop superintendent, was on a vacation and I was doing the best I could to keep things moving. We were handicapped a little by having a new foreman in the

Frank M. Davis was born in Goshen, Mass., 1865. He learned the patternmaking trade, and then took up machine and foundry work. He showed executive ability at an early age, having been foreman and superintendent of shops since he was twenty-one. Mr. Davis was assistant superintendent of the E. P. Allis Co. for nine years, and it was while directing the heavy engine work in these shops that he became impressed with the need for large micrometer calipers of light construction for making accurate measurements. He is now in business for himself as one of the partners of Frank M. Davis & Co., making the Davis tubular frame micrometers and other specialties.

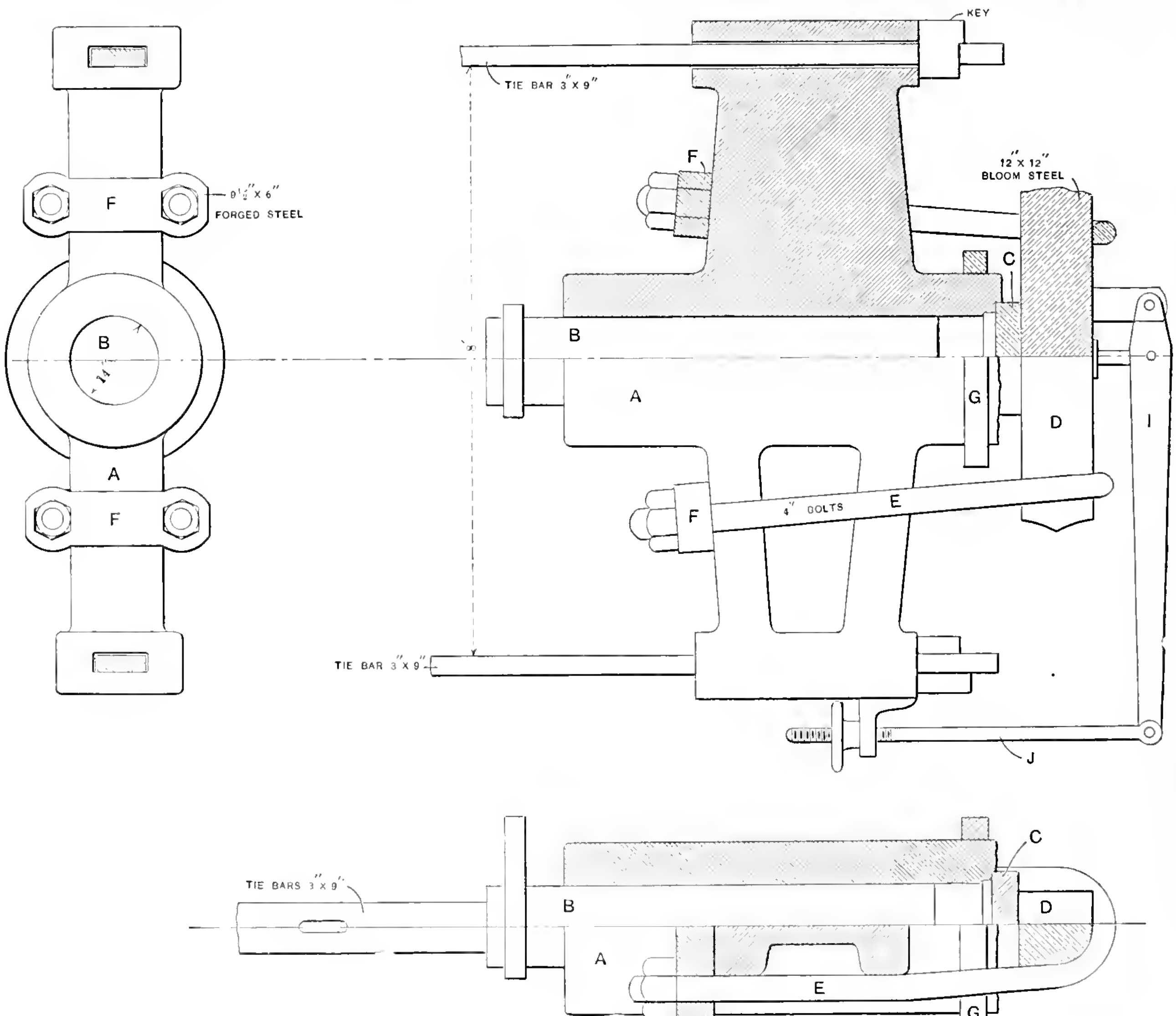


Fig. 1. Showing how a 400-ton Hydraulic Press was given an Emergency Repair.

shop where the press-work was being done and by our old pressman being away at the time. The Carnegie Steel Company had sent inspectors to keep them posted as to the progress made, and I had promised them that the work would be done on Friday. I instructed the foreman to notify me when they were ready to press the work together as I was

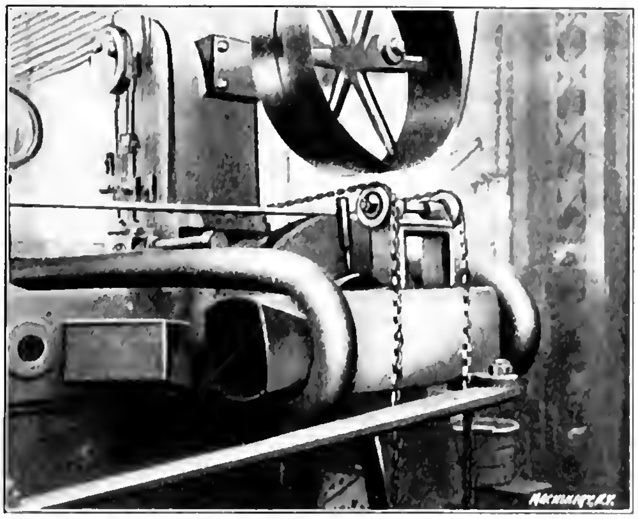


Fig. 2. Rear View of Press, showing Repair.

very busy attending to some other matters. He, being a good man and wishing to push the work as far as possible, thought he would get the pressing started and then notify me, thus saving my time; but, when the pressing was started, the pressure began to run up rapidly, reaching the 400-ton mark before the gears were forced home. Something had to be done quickly and he decided to help the press along; so swung a large ram on the crane, got plenty of men behind it, and began to drive the gear. Meanwhile the small high-pressure pump was at work and the pressure was going up; all at once the back end of the ram cylinder broke off, striking a large lathe and demolishing the change gear, etc. Then it did not look much as though we would ship the job on Friday as this was Wednesday about 5 P. M.

The foreman came to my office and I knew something serious had happened by the expression of his face. "Well, we are up against it; the press is broken." I replied that if this was so we must fix it; the Carnegie job must go as the mill is shut down. A new press cylinder was out of the question, but, by hard work, we managed to get the press together and by 9 o'clock Friday night the gears were all pressed in place, keys driven home, and the job ready for shipping. Extra heavy cars were required to handle the shafts which arrived about 11 o'clock Friday night and the job was loaded on these cars and taken to Pittsburg by special engine. In view of the fact that the press is in constant use and gives no trouble whatever, the repair may be considered of considerable interest, especially when we remember that in a 400-ton press having a ram 14 inches in diameter, the area of which is 153.9 square inches, the pressure may become as high as 5,200 pounds per square inch. Water gets very thin at this pressure.

Referring to the cuts, cylinder *A* was formerly a casting with the back head cast on. It broke off at the ragged line shown in Fig. 3, and I had a seat bored and faced off so as to make the counterbore width one inch all round. A soft steel disk or plug *C* was turned to fit the seat tight and a gasket of copper was placed between the steel plug and the cylinder. *D* is a 12-inch square bloom which we had forged to fit the U-bolts *E* where they went around the bloom. These bolts are 4 inches in diameter and the straps *F* at the opposite end from the bloom are smooth forged 6 x 9½ inches, the holes being punched in the blacksmith shop.

The job was assembled with the press placed on end. Plug *C* and the copper gasket were put in place, and the square bloom bar *D* was placed on top of same and then the U-bolts were shrunk in place. The cylinder was reinforced at the broken end by shrinking around it a steel band *G* 3½ inches square. This was done in order to make sure that there should be no leakage through cracks that might have been developed when the end broke off. In order to let the water out of the cylinder, when the pressure was relieved a hole was drilled through the plug *C* on the bottom side of the cylinder, as shown in Fig. 3, and another was drilled from the side of the plug to intersect it, in which was screwed a drain-pipe to carry the water into the reservoir. The valve was made of a piece of Tobin bronze which was guided by a strap *K* bolted on to the bloom *D*. To this a lever was attached to which was connected the rod *J*, having at the opposite end a coarse pitch screw and a hand-wheel with which to force the valve against the seat. When the press was ready for operation, in place of grinding the valve in, we simply took a heavy sledge and drove the valve home, using the large lever to assist in forcing it against the seat. Notwithstanding this heroic treatment it proved to be tight. It

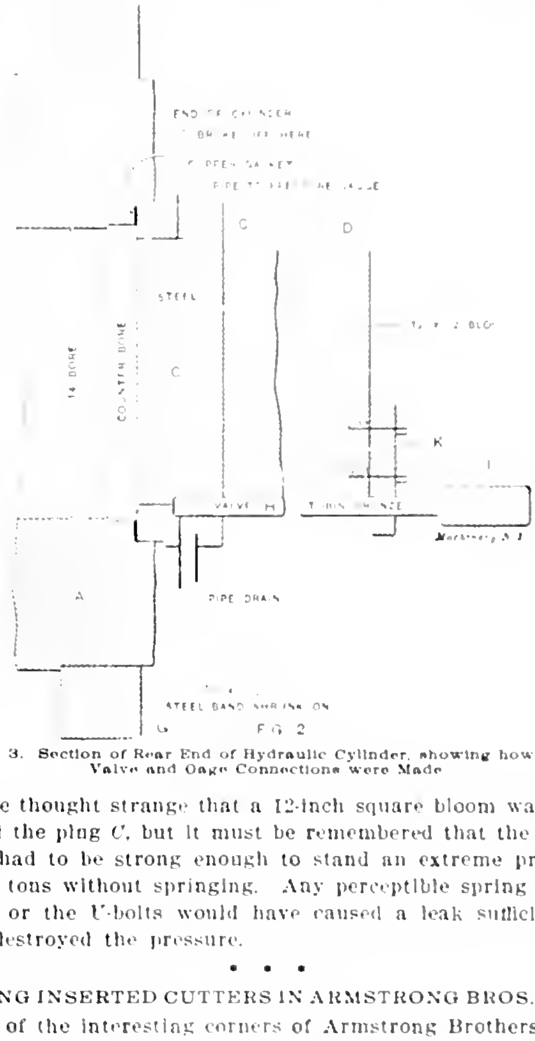


Fig. 3. Section of Rear End of Hydraulic Cylinder, showing how the Valve and Gage Connections were Made

may be thought strange that a 12-inch square bloom was used behind the plug *C*, but it must be remembered that the repair parts had to be strong enough to stand an extreme pressure of 400 tons without springing. Any perceptible spring in the bloom or the U-bolts would have caused a leak sufficient to have destroyed the pressure.

* * *

MAKING INSERTED CUTTERS IN ARMSTRONG BROS. SHOP

One of the interesting corners of Armstrong Brothers' shop in Chicago, the makers of the well-known Armstrong lathe and planer tools, is that in which the self-hardening steel cutters are made. Bars of unannealed, self-hardening steel are cut into lengths of say four inches, using the Armstrong friction disk machine for cutting off. The rods, however, are not cut off at one pass of the wheel in the usual manner of cutting off, but are nicked on all four sides and are then broken apart. The nicking is done rapidly with the friction saw, which is a thin steel disk only 1/32 inch thick. The depth of the cut is about one-quarter the thickness of the bar, and a gage is provided which permits the operator to turn the bar and cut the nicks around it all in the same plane. By nicking the bar all around in the manner described, the work is made easier on the friction saw and a better shaped end on the cutter blanks is assured.

The cutters are ground to shape in the same department and are heated for hardening simultaneously with the grinding operation. The operator forces the point of the cutter against the emery wheel with sufficient pressure to make it red hot, and finishes the point to the proper shape at this temperature. He then throws it into a box underneath an air blast, the result being that the self-hardening steel cools and hardens the same as if it had been heated in a forge and cooled in an air blast in the usual manner.

COUNTERBALANCING AN OSCILLATING ENGINE.

The New Britain Machine Co., New Britain, Conn., are known to readers of MACHINERY as makers of a line of stock racks, bench fittings, trays, shelving, etc., which they style "Shop Furniture." The original product of this company, however, the manufacture of which still forms an important part of their business, was the Case steam engine. This engine runs at very high speed and accordingly is small and compact for the amount of power developed. In order to secure smooth running at these high speeds, however, it was necessary to give careful attention to the question of balancing. The cut-and-try method of determining the proper size and location of the balance weight for different sizes of engines was the one originally adopted, but the results obtained were found to tally so closely with the calculated results by what is known as Beck's counterbalancing formula, that the latter is now depended upon entirely.

Before explaining the experimental work done in investigating the subject of counterbalancing, it will be necessary to explain the peculiarities in the design of the Case engine, although they are familiar to many, and perhaps most of those who will read this. The Case engine has no connecting rod, but, instead, the piston rod carries the crank pin bearing and the cylinder is contained in a casting whose outward form is cylindrical, allowing the cylinder and piston rod to oscillate as the crank rotates. It is an improved form of oscillating engine, eliminating, however, the usual trunnions, and the trouble incident to maintaining steam-tight joints at these points. In Fig. 1 is an outline drawing of the engine showing its exterior appearance, and in Fig. 2 is a diagram indicating the construction of the main working parts and showing also the method of connecting up an indicator for testing the engine. The cylinder casting is at *M* and the bore of the cylinder is indicated by *N*; the piston rod is at *P*, carrying the piston on the upper end and the crank pin bearing at its lower end. In an engine of the ordinary type the path of the piston is forward and back in a straight line, and the piston stops twice during each revolution, at the end of the stroke, when its direction of motion is reversed. In the Case engine, the path of a point *G* on the piston is in the form of an elongated figure 8 and the piston does not come to a dead stop at either end of the stroke. This contributes to smooth action and enables the engine to turn over centers without a flywheel, if desired, and with the light moving parts of the engine permits high speed with small vibration.

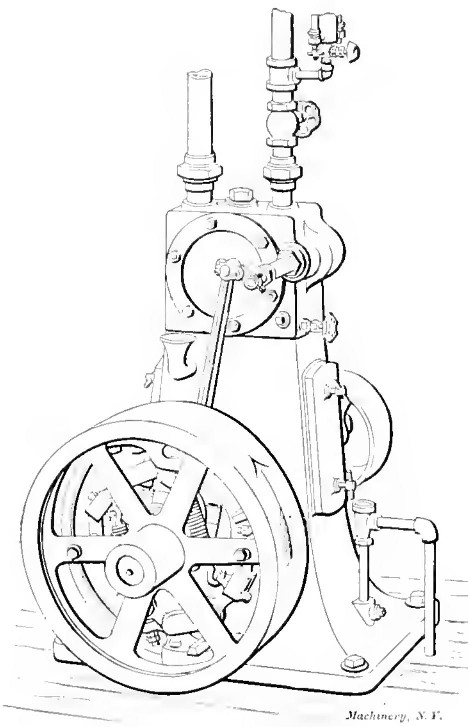


Fig. 1. Case Automatic Engine.

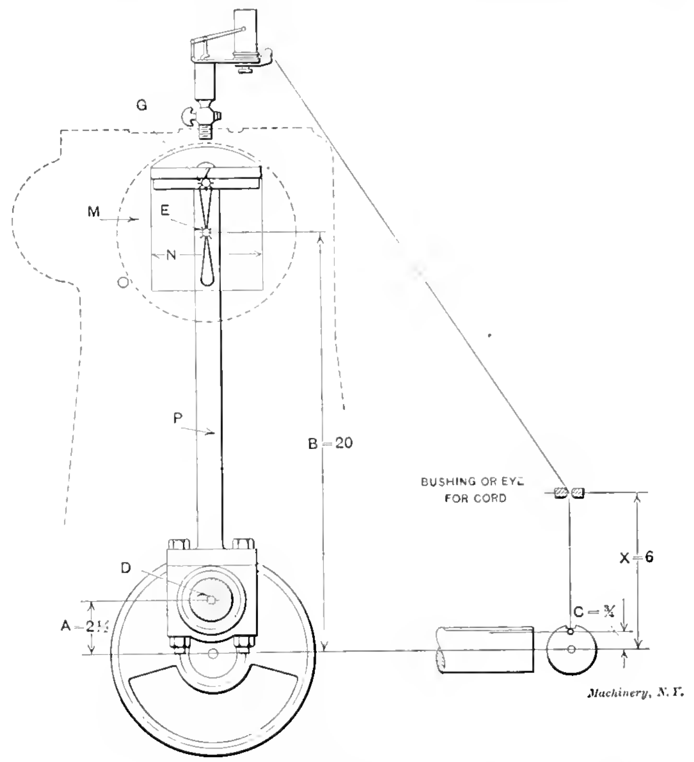


Fig. 2. Diagram of Case Engine, showing Indicator Connections

In preparing for the balancing tests, provision was made for driving the engine under experiment from an external source of power, in order that the vibrations of the engine frame should not be checked or eliminated by steam pipe connections, such as would be necessary if it were driven under its own steam. In Fig. 3 the engine at the right is the one being experimented with and it is driven by belt from the engine at the left. The experimental engine is mounted on a spring board for the purpose of magnifying the vibrations at the top of the frame in all directions. Provision was then made for taking continuous diagrams showing the extent and frequency of these vibrations. The diagram is traced on a

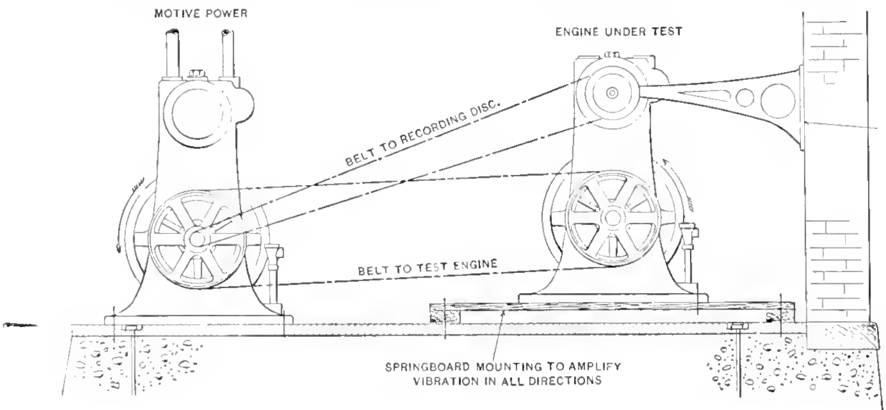


Fig. 3. Engine Mounted for Counterbalance Testing.

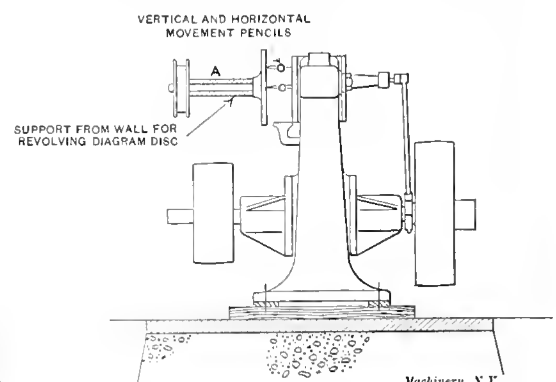


Fig. 4. Showing Rotating Disc for Recording Vibrations.

circular sheet of paper mounted on a rotating disk by two pencils attached to the upper portion of the engine frame. The rotating disk is on one end of a short shaft turning in a bearing at the end of a bracket bolted to the wall near the experimental engine. The bracket is represented in Fig. 3 and a section of the bearing at A in Fig. 4. On the other end of the shaft is a pulley driven by belt from the driving engine.

Fig. 5 Pencil Holder

The two pencils used in tracing the diagram are each mounted in a weighted spring holder bolted to the engine frame, as shown in Fig. 4. One of these holders appears in Fig. 5 and it will be noted that it is made of a piece of flat metal, which allows of vibration in one direction only. By using two such holders, one so located as to vibrate in a vertical direction and the other in a horizontal direction, and by locating the points of the pencils so that they bear against

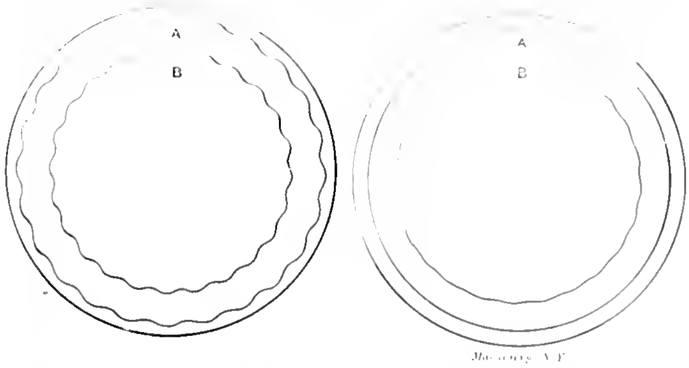


Fig. 6. Diagrams showing Effects of Vertical and Horizontal Vibrations

the rotating disk, two circular diagrams may be traced, indicating, respectively, the horizontal and vertical vibrations of the engine.

In Fig. 6 are two cards, reduced in size, taken by means of this apparatus. The one at the left, having waving lines, indicates that too little counterweight was used, causing excessive vibration both vertically and horizontally. Additions to the counterweight reduced the vibration to practically nothing, as shown in the second card at the right. These two

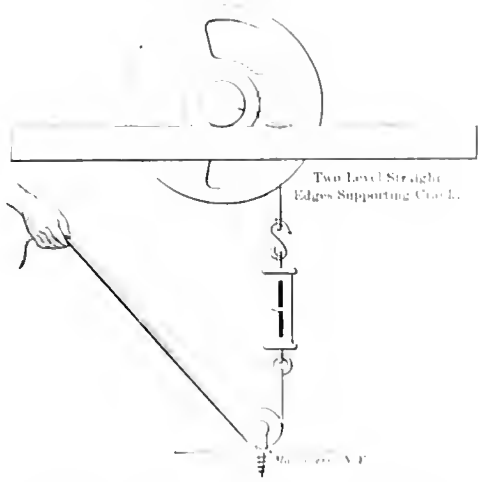


Fig. 7. Method of Weighing Counterbalances

cards were taken from a 13-horse-power Case engine running at 560 revolutions per minute, record A showing the vertical vibrations and record B the horizontal vibrations. As a result of these experiments it was determined that the Beck counterbalancing formula gave figures for the counterweight that were close enough for practical purposes. This formula is as follows:

$$W = \frac{F\,m}{M}$$

where W = weight of counterweight

m = weight of reciprocating mass

M = weight of non-moving mass

F = initial accelerating force.

= R. P. M.^{2} × radius in feet × .00034 × reciprocating mass.

Fig. 7 shows how the weight of the counterbalance is determined in applying this formula.

In further explanation of Fig. 2, which shows the indicator connections for the engine, it will be noted that distance B from the center of piston travel to the center of the shaft is

Fig. 8 Governor of Case Engine

constant, and accordingly, a bushing or eye through which the indicator cord passes is located at a fixed distance, X, from the center of the shaft. The cord coming from the indicator passes through this bushing and is attached to a pin in the end of the shaft, located a distance, C, from the center of the shaft, according to the following proportion

$$A : B :: C : x.$$

In the above, A = length of the crank, and C = corresponding length of the crank operating the indicator cord. The ar-

Fig. 9 Position of Eccentric when Shifted through 180 degrees

rangement, therefore, forms a connecting rod of that part of the cord below the bushing, which is of variable length proportionate to the constantly changing length of the piston connecting rod from D to E. This rule for the indicator connection holds for any type of oscillating engine.

Another feature of interest in connection with this engine is the centrifugal governor, which is so designed as to allow a movement of the eccentric through an angle of 180 degrees or a full half revolution. The oscillation of the cylinder controls the admission of steam, and the shaft governor, which operates the rotary valve, controls the cut-off. In engines where both the cut-off and the point of admission are controlled by the governor it is necessary to shift the eccentric across the shaft as well as to rotate it about the shaft in order to keep the lead constant. Where the governor controls the cut-off alone, however, it is only necessary to rotate the eccentric about the shaft, since the point of admission is controlled by other means. In this latter system full port opening is secured at all points of the cut-off. In the Case governor the eccentric rotates about the shaft and regulates the point of cut-off from zero to practically full stroke. This wide range of cut-off is accomplished by rotating the eccentric through a full half revolution, as stated above. To do this

by a crank and connecting links, without causing the cranks to go on a dead center at either extremity of their travel, advantage is taken of the curved paths followed by the extremity of the weight arm and the eccentric. Fig. 8 shows the eccentric in one extreme position with the weight arms out to the furthest extent; while Fig. 9 shows the eccentric moved through 180 degrees with the weight arms in their extreme inner positions.

* * *

A NOVEL MECHANICAL MOVEMENT.

We have received sketches from a contributor, which show two different methods for raising the sash in green houses. The sketches are reproduced in Figs. 1 and 2 and it is stated that both devices are in use, but that the one in Fig. 2 seems to work easier, although it gives a slower motion to the sash. Point marked S is the shaft, which runs lengthwise of the green house, and the lever connections with the different windows open and close them when the shaft is turned. Fig. 1 is

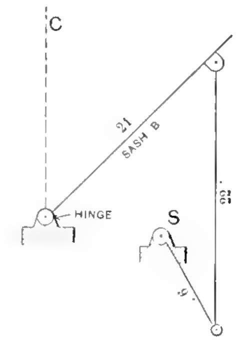


Fig. 1.

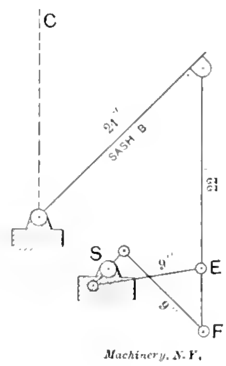


Fig. 2.

a simple crank and pitman movement, and in Fig. 2 there are two cast-iron arms keyed to the shaft, to the ends of which two 9-inch links are attached. These links cross as shown, and at their outer ends are attached to a third link which extends from F to the point of attachment at the sash B. When the sash is opened it takes the position shown by the dotted line at C. Several questions are asked about this mechanism, which we will attempt to answer in what follows, explaining the movement somewhat in detail, but without attempting a mathematical demonstration.

This mechanism is a modification of what is known as Tchebicheff's Approximate Parallel Motion, shown in Fig. 3. The motion consists of four links, one of which, DB, is stationary and forms the base of the apparatus. The opposite link, AC, is connected to the stationary link by the two crossed links of equal length, AB and CD. The central point O of the link AC will move in approximately a straight line

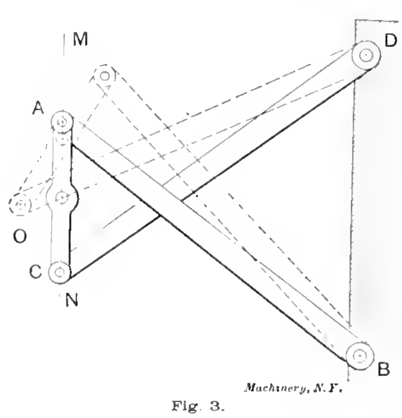


Fig. 3.

when the link AC travels up or down, provided the several links are proportioned correctly. Calling the length of link DB equal to 4, than AB and CD should each be equal to 5 and AC equal to 2. The dotted lines in Fig. 3 show the positions of the parts when link AC is raised a short distance.

Fig. 4 shows the straight-line motion in a modified form, such as might be used to raise the sash of green houses or for raising any other weight. The change in the mechanism consists simply in making DB a movable link and pivoting point O in a stationary bearing, point O corresponding to the center of shaft S in Fig. 2. The parts of the mechanism are lettered the same in Figs. 3 and 4. The dotted lines in Fig. 4 show the two extreme positions, up and down, into which it is possible to bring the link DB by rotating the shaft. In the extreme upper position the different pivots are located at points A', C', D', and B', and in the extreme lower position at A'', C'', D'' and B''. It will be noted that for half a turn of the shaft, or a movement through 180 degrees, link DB will have traveled a distance L. In order to compare this with the simple crank movement of Fig. 1, the upper diagram, Fig. 5, has been drawn, showing that to effect a movement L, equal to the distance L in Fig. 4, the lever will have moved through an angle of but slightly more than 45 degrees, assuming length of lever to be 9 inches. In other words, it has been necessary to rotate the shaft nearly four times as far in the mechanism of Fig. 4 as in the other case, to produce a given

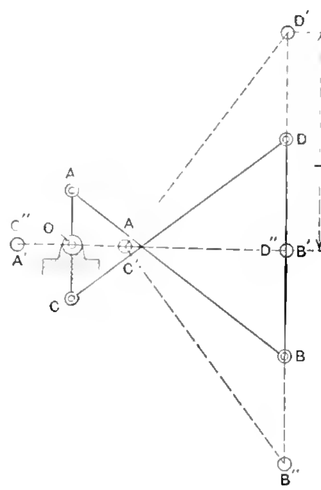


Fig. 4.

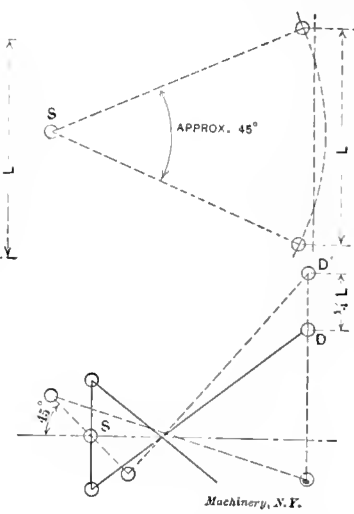


Fig. 5.

movement of the link: and neglecting friction loss, which would be more in the former than in the latter, the shaft in Fig. 4 should turn nearly four times as easily as the shaft in Fig. 1, and nearly four times as great a weight could be raised with the former as with the latter. The effect of the linkage of Fig. 4 is substantially the same as though the shaft S, in Fig. 1, were geared up to a crank on one side of the shaft, with two pinions in the ratio of 4 to 1, the larger pinion being on the lifting shaft and the smaller one on the crank shaft.

When this motion is used for raising the sash of a greenhouse, it is evident that the point of attachment to the sash does not move it in a straight line and hence the link DB does not remain in a vertical position. This makes no difference in the principle of its operation, however, since the mechanism will work equally as well whether a point on the link DB is guided in a straight line, or is compelled to travel in a curved path.

Another interesting point about this straight-line motion is that the velocity ratio between the shaft and the link DB at the outer end of the connecting links, is very nearly constant, as is shown in the lower diagram in Fig. 5. Here the shaft S is represented as having turned through 45 degrees, or $\frac{1}{4}$ the distance that it turned in Fig. 4, where the movement of the link DB was equal to a distance L, and it will be noted that the distance traveled by point D of the link in Fig. 5 is also practically $\frac{1}{4}$ L, showing the velocity ratio of the mechanism to be very nearly constant.

* * *

The zapote tree which grows in Mexico is remarkable for the extreme hardness of the wood when it has become thoroughly seasoned. U. S. Consul A. J. Lespinasse, at Tupam, Mexico, writes, that although zapote wood is easily worked when green, it is so hard when seasoned that only the finest-edged tools have any effect on its flint-like surface. Sharp-pointed nails can be driven into the wood only about an inch, and the fiber is so dense that the wood sinks rapidly in water and will remain immersed for years without being affected in the least. The chicle sap which exudes from the tree when tapped is very viscous when partially dried and is very adhesive; this property makes it very valuable for repairing broken articles and it is largely used as a cement for fastening leather tips to billiard cues, etc.

RESISTANCE OF JACKETED BULLETS WHEN FORCED THROUGH THE BORE OF 0 30 CALIBER RIFLE BARRELS.

The passage of a bullet through a rifle gun is by no means a simple action, but, on the contrary, is quite complex. The force generated by the burning powder is expended in overcoming the inertia of the bullet to motion in a direction parallel with the axis of the bore; in overcoming the inertia to gyration on its axis, and the friction of the bullet in the bore of the gun. The force required to accelerate the bullet and to give it the gyration required by the rate of twist of the rifling, may be calculated; but the resistance due to friction is an unknown quantity which is only determined by test.

Some experiments have been made at the Watertown Arsenal to determine the resistance of jacketed bullets when forced through the bores of .30-caliber rifle barrels. The tests were made with barrels having a twist of one turn in 10 inches, and one turn in 8 inches, respectively; and jacketed bullets were used having bearing surfaces 1/4, 3/8, and 1/2 inch long respectively. The accompanying diagram, Fig. 1, shows the resistance curve of a steel-jacketed bullet when forced through the bore of a barrel having a twist of one turn in 10 inches, the bullet having a bearing surface 1/4 inch long. The bullet was pushed slowly through the bore by a hydraulic piston, and the velocity was a variable factor until a distance of about 11 inches had been traveled, after which it was uniformly about 0.083 foot per minute. The highest resistance recorded was 1,048 pounds, which was developed 0.55 inch from the start. The average resistance was about 65[illegible] pounds.

Fig. 2 shows the curve resistance of a steel-jacketed bullet having a bearing 3/8 inch long. It will be observed that the velocity with which the bullet was forced through the bore was again quite variable, averaging about 0.07 foot per minute. The highest resistance was 1,008 pounds, which was developed 2 1/2 inches from the start; it averaged about 880 pounds.

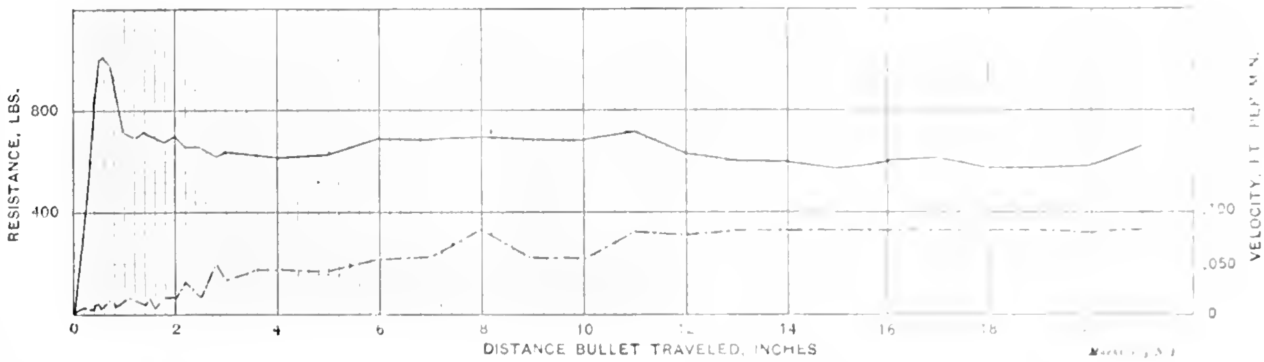


Fig. 1. Curve of Resistance of Steel Jacketed Bullet when Forced through the Bore of a 0 30 Caliber Rifle Barrel Bullet with Bearing Surface 1-4 inch long

Fig. 3 is the resistance curve made with a barrel having a twist of one turn in 10 inches, but the bullet had a bearing 1/2 inch long. The average rate of velocity employed in forcing the bullet through the bore was about 0.07 foot per minute. The resistance averaged about 920 pounds, the highest resistance being 1,096 pounds, 11 inches from the starting point, when the velocity was 0.083 inch per minute.

When a bullet having 1/4 inch bearing was forced through the barrel at the rate of one foot per minute the barrel was perceptibly warmed, and the maximum resistance reached 1,800 pounds, dropping to 1,450 pounds until the bullet had traveled nearly through. The resistance of a bullet having a bearing of 1/4 inch in a barrel having a twist of one turn in 8 inches reached a maximum of 956 pounds 0.65 inch from the start, and averaged about 720 pounds for the travel of 21 inches; with a bullet having a bearing surface 3/8 inch long the maximum pressure reached 1,295 pounds 11.5 inches from the start, and the pressure averaged about 1,120 pounds; and a bullet having a bearing surface 1/2 inch long gave a maximum resistance of 1,198 pounds 15 inches from the start, the average resistance being about 1,080 pounds. Diagrams are not shown for the tests mentioned in the last paragraph

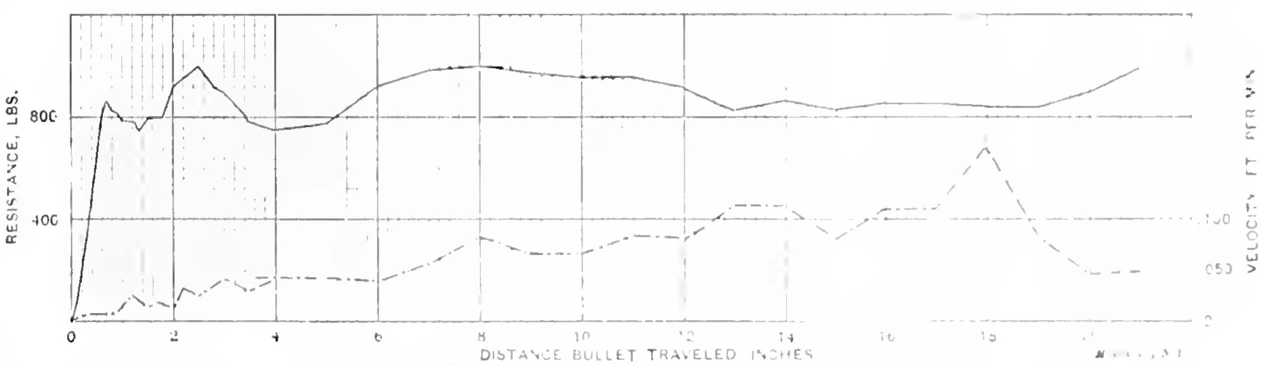


Fig. 2. Curve of Resistance of Steel Jacketed Bullet when Forced through the Bore of a 0 30 Caliber Rifle Barrel Bullet with Bearing Surface 3 8 inch long

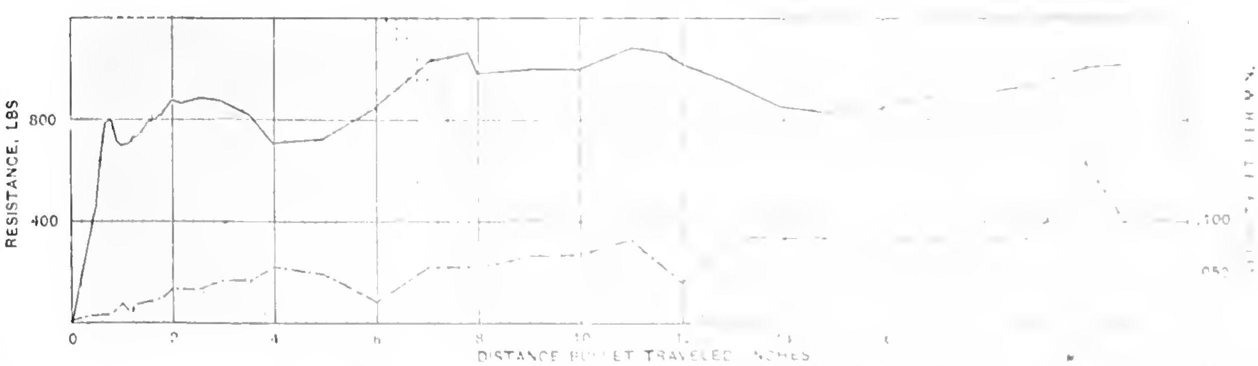


Fig. 3. Curve of Resistance of Steel Jacketed Bullet when Forced through the Bore of a 0 30 Caliber Rifle Barrel Bullet with Bearing Surface 1 2 inch long

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THE LIMIT IN PUMPING MACHINERY.

It is to be expected that the attention now being given to centrifugal pumping machinery, especially to the multi-stage type for delivering comparatively small bodies of water against high heads, may lead to the perfection of larger sizes of such machinery. The need for this is demonstrated in the recent installation of a Leavitt 72,000,000-gallon sewage pumping engine at Boston. This engine was built by the I. P. Morris Co., Philadelphia, Pa., who have constructed much of the Leavitt machinery. Certain parts of this engine are so massive that it was impossible to ship them by rail and they were carried around by water on a 1,500-ton barge. Some of the weights of the parts are as follows: Beams and pins, 50,000 pounds; low-pressure cylinder, 40,000 pounds; beam pedestal bed plate, 34,000 pounds; plunger, 30,000 pounds; upper pump chamber, 26,000 pounds; crank shaft, 23,000 pounds, etc. The total weight of the engine and pump is about 1,700,000 pounds. There are two single-acting pump plungers 60 inches in diameter and having 120 inches stroke.

Pumping engines of this type represent the extreme limit in expensive construction for the work that has to be done. The number of dollars required to pay for each horse-power of engine is something extraordinary. Not only is no expense spared to produce a machine that will operate on low steam consumption, but the mere cost of cast iron and steel is a large item, as shown by the weights given above. The Boston engine runs at 17 revolutions a minute only, and at such a speed it must necessarily be large and massive.

Centrifugal pumps, on the other hand, are compact, simple, comparatively inexpensive and run at high speed. The objection to them for drainage and water service, where large volumes of water are handled, is their inefficiency. The losses in smaller pumps of this type, however, have been gradually diminished during the past few years, and it is reasonable to suppose that corresponding improvements will be made in the larger ones. A number of years ago the New Orleans Drainage Commission installed several very large centrifugal pumps, which is the most important application of this type of machinery that has yet been made. One of these pumps has a capacity of over 300 cubic feet per second. The discharge outlet is 6 feet in diameter, and the pump is driven by a 500 horse power motor. The efficiency of the pump was found under test to be 74 per cent. This may be compared with the Leavitt engine, installed in Boston at the Main Drainage Works about twenty years ago. The efficiency of this engine and its pumps, taking into account both the losses in the mechanism and the losses through slip, was about 80 per cent. It is probable that in some recent engines this efficiency might be increased to perhaps 85 per cent., although this is doubtful. If we consider the mechanical or electrical losses of the motor required to drive a rotary pump like that at New Orleans, it is probable that the total efficiency would be reduced to about 70 per cent. There is thus much to be done before the centrifugal pump can compete in efficiency with the plunger type; but on the other hand, both the first cost and the expense for attendance are very much less. We believe that in the near future the performance of both from the commercial standpoint will be practically on a par.

* * *

EMERGENCY REPAIR JOBS.

A superintendent of a machine shop doing a wide variety of work, some of which is of an emergency nature, must be more than an ordinary mechanic if he is to succeed. He must possess the faculty of quickly deciding the best way of doing any job, and in great stress must often have the courage to do it in a way that might be considered unallowable ordinarily, but which serves the purpose in getting the desired result. The description of the 400-ton hydraulic press repair by Mr. Davis, on another page, is a good example of executive ability and is well worth reading for that feature alone, to say nothing of the information as regards the mechanical details. A mere mechanic, carefully trained to the nice ways of doing work, would be little less than horrified at the heroic way of fitting the Tobin bronze valve to its seat, *i. e.*, driving it in with a heavy sledge, but it is in such matters as this that the successful shop manager rises to the occasion and "gets there" while the other man perhaps would be lost in trying to follow the ordinary methods learned in the trade. In the building of machinery, as well as everything else in general, results are what are desired; but the trained mechanic is likely to think more of the conventional ways and means employed than of the ultimate purpose for which he is working. It is this condition of mind which is to be eliminated to a large degree when brought face to face with emergency work of the character discussed. The valve was required to be tight against its seat; it mattered not, so far as the press job was concerned, whether it was made tight by careful grinding of flour emery and the expending of hours of time, or whether it was driven home with a sledge. After the repair was made they could well afford to remove the valve and replace it with a new one, if need be, carefully fitted in the conventional manner. Its cost was insignificant compared with the heavy loss to some one that would have been caused by not getting the job done on time. To sum up, a mechanic should learn when it is possible and best to sacrifice small details in order that results may be accomplished; in other words to acquire a prospective judgment that shall enable him to accurately value things.

* * *

A mistake that is frequently made in gas engine design is to assume that the bolts through the connecting-rod basses have little or no work to do beyond merely holding the rod and crank-pin together, inasmuch as the ordinary type of gas engine is a single-acting machine and the rod is supposed to be always in compression. Such is not the case, however, since the force required to accelerate the piston on the ends of the stroke is always considerable, and with short connecting-rods and heavy pistons it may be, momentarily, equal to or even greater than the normal pressure due to the explosion. Moreover, when an engine is running without charge due to its momentum the piston is not cushioned as it is under working conditions. Hence the importance of proportioning such bolts so that they shall be strong enough to transmit the full power of the cylinder through the connecting-rod in tension as well as in compression.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH

A recent consular report from Nottingham, England, states that a Lancashire mechanic has invented a sewing machine which sews direct from two spools of thread, thus obviating the winding of bobbins and the threading of shuttles. The new machine is simple in construction and it is believed that the improvement will revolutionize sewing machine construeton.

The new Sherardizing process for galvanizing iron and steel which is being exploited in Great Britain is said to protect the metal from corrosion to a remarkable degree. Even after the apparent removal of all the zinc by cutting or filing, the abraded surface of the iron is still noncorrosive. This valuable property is attributed to the protective action of the zinc-iron alloy formed on the boundary line between the iron and zinc.

With the completion of both bores of the great Simplon tunnel through the Alps, through which trains will soon be running regularly between Brig in Switzerland and Iselle in Italy, comes the announcement that another Alpine tunnel is projected through the Bernese Alps from Frutigen to Raron. If this tunnel passes under the Lotschberg, as projected, it will be the longest in the world, having a length of 13.07 miles. The Simplon tunnel just completed is 12.26 miles; St. Gothard 9.31 miles; and Mount Cenis 7.98 miles. The estimated cost of the new tunnel is $12,376,000, but it is thought more likely that it will reach $16,000,000.

An interesting character sketch was recently published in the *English Mechanic* on Bertha Krupp, the so-called "millionaire girl gun-maker," which incidentally mentions a strange arrangement of the works; and that is that every gun, musket or other firearm that leaves the Krupp factory is tested in a vast tunnel. "Periodically the whole town of Essen, which is built over a maze of exhausted coal galleries, rocks and reverberates as the guns are fired. The crash within the tunnel is appalling, and the strongest men cower in terror when they first stand in the horrible place and hear the roaring of the guns in the depths." Notwithstanding these terrors it is alleged that Miss Krupp insisted on being present at a firing trial, such is her devotion to duty.

In a paper on "High-Speed Tool Steel," read by Mr. Arthur B. Corby before the Salford Science Students' Association, April 8, 1905, the author referred to the defective design of tool-rest found on most American lathes and said that in this regard the English type of tool is far ahead of the American. The support of the tool, especially when made of high-speed steel is of vital importance. High-speed steel more than any other seems to have a peculiar property of sharpening itself by the action of the work and the wear of the chips. Even when a tool has shown signs of failing it will pick up in a wonderful degree if held to the work; but if, when it begins to fail, the work can push it away at all, it will soon break down altogether. Hence the importance of supporting the tool in the most rigid manner possible.

The tunnel system of Chicago, which was built underground in two senses of the word—the work being carried on without the knowledge of the great majority of the citizens—was ostensibly projected at first as a system of electric wire conduits, but was afterwards extended to include a system of narrow-gage freight tracks. It is alleged that the system will aggregate 132 miles of electric railway underground when completed. Its purpose is to supplant the business of trucking in the streets, the plan being to have basement entrances into the large establishments having a great volume of freight to handle. The system seems an ideal one as it will eliminate a large part of the traffic with which business streets are ordinarily congested, and will be quicker and more reliable than the horse-drawn truck.

The Naxos-Union, Frankfort-on-Main, Germany, makers of emery wheels, have an interesting method of securing trade and at the same time getting an exact expression of a customer's wants in the matter of emery-wheel shapes. Sheets of gummed paper, perforated so as to make small rectangular sections similar to postage stamps, are sent out to prospective buyers. Each space carries a cross-section cut of an emery wheel type, with the dimensions left blank. The customer is expected to fill out the blank dimensions and paste the sticker to his letter. When this is done there can scarcely be any mistake in the type of wheel desired. If some equally as simple and effective method of securing an expression of the grade of wheel could be devised, it would greatly simplify the emery wheel problem for the manufacturer. Practically all users know what shape of wheel is best suited to their work, but many do not know the grade of grit that is most effective.

The Times Engineering Supplement says that in his recent series of lectures on "Flame," at the Royal Institution, Sir James Dewar illustrated in a striking form a fact which has long occupied the attention of scientists in relation to the energy expended in the production of light. The following figures show how utterly imperfect are the various lighting devices now employed on a basis of scientific efficiency:

	Percentage of Light	Non-Luminous Energy
Candle	2	98
Oil	2	98
Coal gas	2	98
Incandescent lamp	3	97
Arc lamp	10	90
Magnesium lamp	15	85
Cuban firefly	99	1

Considerable interest has been aroused in the commissary department of the United States Army in the investigation of the so-called fireless cooking stoves which have been used many years in some European countries. The fireless cooking stove is simply a double wooden box packed with hay or other insulating medium in which the food to be cooked is placed and closely shut within. It is given a preliminary boiling of a few minutes and then, in tightly covered crocks is placed within the "hay box," so-called, and left for a number of hours during which time the heat which is conserved by the excellent insulating walls, completes the cooking operation. The hay-box, or fireless cooking stove, enables food to be well cooked with a very small expenditure for fuel, and, of still greater importance, it permits the food to be cooked thoroughly with practically no attention. In the army service it would be possible to have food cooking while in transport, etc.

The use of pure nickel for coinage is advocated by Mr. Albert Ladd Colby in the *Iron Age*. Our present nickel coinage is confined to the five-cent piece which is an alloy of nickel and copper. It is pointed out that pure nickel coins resist wear better than the alloy coins and the imprint lasts longer. Also that heavier and more powerful dies are required, thus making counterfeiting more difficult. Another incidental advantage of the pure nickel coin is that it is attracted by a magnet whereas the alloy coin is not. Notwithstanding the fact that the "nickel" is a very convenient coin, we think that it is a mistake to advocate the extended use of nickel for coinage even though it may be a superior metal for this purpose. We do not think that anything should be done by the government to increase the intrinsic value of nickel, for it is already too costly from the stand of the would-be user of nickel-steel. From an economic view point the price of nickel could be very advantageously reduced inasmuch as it would greatly extend the uses of nickel-steel in the constructive arts, and we consider these as of much more importance than that of mere coinage—silver and gold are good enough for that.

In long transmission of power, high voltage means economy in the cost of the transmission line, but under the present conditions affecting electrical generators it is necessary to use step-up transformers in the power station to secure the higher voltages that are used on the longer lines. The transformer, while very efficient, means a certain loss of efficiency, 2½ per cent probably being a conservative figure. The *Electrical World and Engineer* suggests that the construction of generators may be improved so that the need for step-up transformers will be eliminated. It suggests that oil insulated generators be built and in this way generate high voltage directly instead of using the transformer as an intermediate apparatus. While the oil-insulated generator would mean a larger and more expensive machine, it would eliminate the loss due to transformation and considerably simplify the present central station construction.

In a paper upon electric motors read by Mr. H. C. Fashbough before the ninth meeting of the Ohio Society of Mechanical, Electrical, and Steam Engineers, the author refers to the curious fact that central station engineers lay great stress on efficiency when purchasing steam boilers, engines and dynamos. They will limit the variation of efficiency from the highest attainable for the type to a few per cent, but when it comes to the matter of electric meters, they will be purchased almost entirely with reference to price alone, without regard to their efficiency. Now when it is considered that an electric meter is the measuring device by which the revenue is determined, it would seem that this practice is very short-sighted. It is very much on a par with the practice of a merchant who would use scales of very questionable accuracy; one scale might weigh correctly and another indicate from 10 to 20 per cent less than the actual weight of the goods sold, or *vice versa*.

The British Admiralty are to build a war vessel of new type that is a radical departure from previous practice and, should it also prove to be an advance over the older types, will probably have a marked effect upon the warfare of the future. The new ship will be a battleship of the heaviest type and will mount a battery of ten 12-inch guns as against the four 12-inch guns usually carried. There will, however, be no intermediate battery of 6-, 8- or 9-inch guns; but there will be a large number of high velocity 3-inch guns for repelling torpedo boats' attack. Not less remarkable than this battery equipment, however, is the engine power provided, which will be capable of driving the vessel at a speed of 21 knots an hour, or as fast as a high-speed cruiser. To accomplish this, turbines are to be installed of 23,000 horse-power. This is the first instance of the use of turbines on war vessels of large size; although they are being adopted in some cases for naval vessels of small size, largely for the purpose of experiment.

Mr. R. A. Hadfield, in his presidential address before the Iron and Steel Institute, May, 1905, referred to the curious fact that the natives of West Africa are able to produce by a very crude method a high carbon steel which it is difficult to surpass by any modern process. A chisel made of this steel analyzed 1.08 per cent carbon, and all the other elements including silicon, sulphur, phosphorus and manganese, were under 0.10 per cent. While it may be a matter for some wonderment why this primitive steel, which, in common with the steels made by primitive processes in other countries, is so remarkably free from impurities, still, when we reflect, it is not so strange. If the steel did contain certain impurities such as sulphur, for example, it would not be good steel. In short, the primitive steel maker found that certain materials and certain methods of working produced a good metal, the same as the modern steel makers know. If he deviated from a certain line of procedure the steel produced was inferior. Hence, the good product survives while the mistakes are lost. In other words, primitive steel making is probably only another example of the tedious way in which mankind has learned by experience what will and what will not produce a desirable result.

A new high-speed steel called "Unor" is being made by Sheffield Steelmakers, Ltd., Sheffield, Eng., which promises to be an important brand inasmuch as it is much cheaper than most other brands on the market. The price, it is said, will be something like 18 cents a pound delivered in America. It is an air-hardening steel and all that is necessary to harden it is to heat it to a bright red and not beyond the critical point as is the case of many brands of high-speed steel; it is then allowed to cool naturally in the air, without the use of an air blast. It is annealed by heating it a cherry red and letting the heat subside to a very dull red and then plunging into water. Experiments have proved that it can be hardened and softened any number of times without deteriorating the wearing qualities of the steel. Some twist drills made of "Unor" steel were recently tested at the Sheffield Testing Works, drilling a 0.49 carbon steel locomotive tire made by Camel & Co. In this test 49 holes, each 15/32 inch in diameter, and 1⅞ inches deep were drilled at an average speed of 25 seconds each. A 13/16 inch hole drill made from this steel drilled 20 holes 2 inches deep in 16½ minutes, and in both cases the drills were left in good condition.

A paper was presented by Mr. Sydney A. Houghton to the May, 1905, meeting of the Iron and Steel Institute, which gave an interesting example of the failure of an iron plate from fatigue. A traction engine, of the locomotive type used for plowing, exploded with disastrous effects, killing one man. The failure of the barrel was found to be due to the action of the front pedestal bearing with which the barrel of the boiler was supported on the forward axle. The working of the engine over rough ground caused the pedestal to exert a bending effect on the boiler plate which eventually cracked it, thus causing the explosion. Undoubtedly many boiler failures might be traced to a similar cause, especially those of the portable type having the machinery and wheels supported by the boiler which thus takes the place of a frame. While boiler construction is very well adapted to the support of machinery, it may be affected by it in bad designs in such a way that the plates in the immediate vicinity of the supporting pads are subjected to alternating bending stresses which eventually deteriorate to such an extent that they give way. Not every explosion of this character receives the critical examination of that on which Mr. Houghton bestowed his attention.

In the early days of lathe construction when power-driven lathes were unknown, catgut bands were almost always employed for transmitting motion from the foot wheel to the spindle. The great strength and long-wearing qualities of catgut make it a material unapproached by any other for the purpose, yet, seemingly, with the advent of power-driven machinery, its value as belting material has been largely lost sight of. But when it is considered that a catgut cord only 1-10 inch in diameter will work efficiently under a tension of over 300 pounds, for long periods, it is obvious that the material is good for something else besides violin strings. In short, the use of catgut belting for certain machinery should prove much more profitable than leather or other material. Attention is called to the value of catgut for belting by Mr. J. N. Raffard, in the May 31st issue of *Revue de Mechanique*. He says that it will work effectively under a tension of nearly 4,300 pounds per square inch, or ten times the allowable loads for leather belts. A round cord of catgut 0.39 inch diameter should do the work of a leather belt 6 inches wide and 1-5 inch thick. It should be used, however, in endless form as belt or screw fasteners of any kind cause a serious loss of strength. Of course, an objection to the general use of catgut belting is its cost and the small sizes only in which it is available. Another objection, not serious, however, is that it is slightly hygroscopic, *i. e.*, changing with the dampness of the weather.

It is a fact well-recognized, and one previously alluded to in MACHINERY, that much of the progress in the metal-working arts is due to the contest between guns and armor. Processes have been devised and great shops have been built for making armor plate which shall resist the highest power guns, and in

turn, as equally strenuous efforts have been made to devise gunpowder, and projectiles which shall destroy the improved armor plate. The equipment of an armor plate shop or mill is of the most costly character and it is somewhat startling to hear that all this equipment may be rendered of little value by an armor plate process in which the steel is cast instead of being forged. The possibilities of manganese steel in this direction are being exploited and the results indicate that it is possible to make a manganese steel armor plate by the casting process, which equals in every respect the best Krupp cemented plates. A 6-inch unforged, capped manganese shell has perforated a 6-inch Krupp cemented plate when impelled with a powder charge that gave it a striking velocity of 2,000 foot-seconds. The possibility of making armor plate by casting, of a material almost invulnerable to attack, shows how, in the progress of the arts, the complicated gives way to the simple; that improvement is generally an elimination of features which cost time and money and which in the light of progress are found unnecessary. While manganese armor plate will seem like a great achievement, the use of the same material for railway frogs and other purposes will work a far greater change, no doubt.

One of the conditions which must very unfavorably impress the visiting foreigner is the dangerous state of many of the streets of our large cities, especially where extensive improvements are being made. Where excavations are necessary they are usually protected, it is true, by some sort of railings, but they are generally put up in a perfunctory manner, seemingly more for appearance than for actual safety of the public. This state of affairs has been very apparent in the building of the subways in New York City and Brooklyn. Much of this work was done by open cut excavation, the streets being uncovered at the sides, leaving the surface railway tracks suspended, as it were, in mid-air. A miserable railing of rough boards placed two or three feet from the track was generally the only guard provided for preventing accidents and these were usually a greater source of danger than the chasm. So poorly fastened are they along the subway route in Brooklyn that only a slight shock is necessary to loosen the ends of a board which then, as like as not, would swing around and impale some unlucky passenger in a passing car. That such conditions are nothing less than criminal seems to be dimly understood by the great mass of our population. A similar condition in England, for example, would call forth such a storm of protest that no contractor or construction company could ignore it. Here everyone seems to think that a public condition which does not immediately but only remotely concern him, is one that he need not pay any attention to.

Peru possesses a valuable element in the yet undeveloped hydraulic power which exists on both the eastern and western slope of the Cordillera of the Andes. The source of this water supply is the ice cap above the line of perpetual snow which crowns the summit of the range, and the continual and exceedingly heavy snow and rain storms of the high plateaus. All along this vast chain, from Ecuador to Chile, there exists a series of lakes, practically astride the summit of the Andes, at altitudes varying from 12,000 to 17,000 feet above sea level, and these, together with the streams to which they give rise, form the source of enormous hydraulic energy. The volumes of water which descend upon the Pacific side are not necessarily very great, but they are numerous and constant, and their fall is exceedingly rapid. As an example, the river Rimas, which rises in the ice cap of the Cordillera, at an elevation of more than 17,000 feet, debouches on the coast of Callao, with a course not more than 80 miles long. This river is already used as motive power for generating electricity for the railway between Lima and Callao, and could furnish constant and unlimited power over any portion of its course. Similar conditions exist, more or less, with the numerous other rivers and streams all along the 1,500 miles of Pacific littoral belonging to Peru. On the eastern slope of the Cordillera the volume of the streams is greater, for the rainfall is far heavier, due to the well known climatic conditions to which the Andes give rise. In short, the Andes may be considered as a mighty engine, continually intercepting and storing up the moisture of the continent upon its summits, and thence discharging it again under such conditions as create energy in a limitless form and available for the uses of man.—*Consular Report.*

Mr. H. M. Lane outlined a plan for making a molder in a paper read before the New York meeting of the American Foundrymen's Association, June 6-8. The prime evil that affects most apprentices is that they are affected with the "big wages quick" mania. As a consequence, many boys spend about half their apprenticeship in one shop and then quit and go into another shop where they can get journeymen's wages. Mr. Lane proposed that a trade school for molders be equipped for the manufacture of a broad line of machinery. The plant should be large enough to employ 1,000 hands in all departments and it might manufacture machine tools, lathes, planers, milling machines, drill presses, grinding stands, gas engines, steam engines, sheet metal-working machinery and wood-working machinery. Connected with the establishment there would be a corps of teachers and a regular course would require four years, distributed about as follows: nine months in a series of shop work corresponding closely to that given in manual training schools. During this period he would receive no pay. When the boy enrolls he would be expected to pay down $100, and if at the end of nine months' preparation he decides that the trade is not to his liking, he should be allowed to go and be given back half of the money paid in. If he wants to go on with the trade he would be put first on to molding machines and taught how to make a large number of different classes of molds in this way. From the molding department he would pass to the core department and from the core department to the light work floor, and then to the heavy work floor where he would receive instruction both in green sand and dry sand work, also in loam work. This course would occupy approximately two years and three months. The last year should be elective, the boy being permitted to choose his specialty and spend his last year on it.

A type of street car is used in Cincinnati, Ohio, and some other cities which has a narrow, enclosed vestibule in front for the motorman, and an extended vestibule at the rear for the conductor and the incoming and outgoing passengers. The large rear vestibule is for the convenience of smoking passengers who stand behind a rail which guards the passageway to the interior of the car. This idea has been extended in Montreal in such a way that all passengers pay their fares before entering the car. These cars have the rear vestibule platform 7 feet long, which gives standing room for about 20 passengers. The conductor stands at the inner doorway and collects fare from all who enter. The large vestibule allows a large number to get on without making any delay for the collection of fares, this being done as they enter to the seats. No one is permitted to enter at the front platform although passengers may make their exits at that platform, the door being opened by the motorman by means of a lever which he operates with his foot. The advantages of the system are that all fares are collected, and that the conductor always stands at the rear of the car, where he has full control of the car and can fully observe the movements of the incoming and outgoing passengers. It also saves the passengers the annoyance experienced on trolley cars of having the conductor squeeze through to collect fares. A large proportion of the accidents which occur on street railways are directly traceable to the inability of the conductor to attend to his other duties and collect fares on crowded cars. The Montreal system is one that should appeal to the traveler, conductor and street railway manager alike. One objection to the scheme is that such cars can only run in one direction and loops would have to be provided at the terminals so that the cars can turn completely around before starting on return trips. For service in large cities where street accidents and blocks are frequent, which cause cars to start on their return trips before reaching the terminal, this drawback would be a somewhat serious objection.

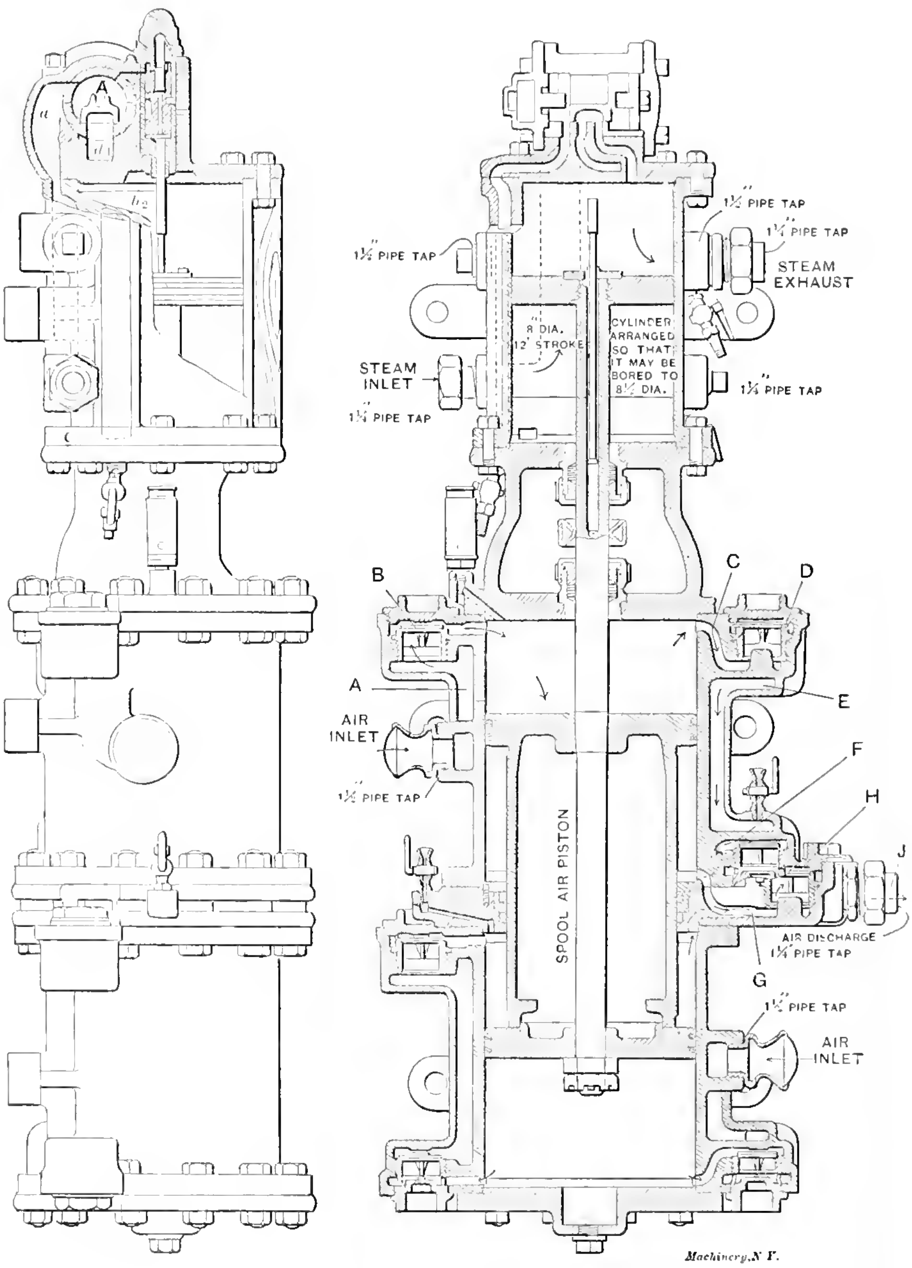
WESTINGHOUSE COMPOUND AIR PUMP.

A new Westinghouse air pump of the compound type was exhibited at the Manhattan Beach convention of the American Railway Master Mechanics' Association, and a description of this pump showing its internal construction and method of operation was given by Mr. F. H. Parke, of the Westinghouse Air Brake Company, in a recent issue of *Railroad Gazette*. The new pump comprises three cylinders placed vertically in tandem; the upper cylinder is the steam cylinder and is 8 inches in diameter, having a stroke of 12 inches. The air cylinder end of the pump consists of two 11-inch cylinders joined by a short centerpiece having an $8\frac{3}{4}$-inch circular opening fitted with packing rings, as shown in the sectional view, Fig. 2. The air piston is spool-shaped, the ends being 11 inches in diameter and the small diameter of the spool being $8\frac{3}{4}$ inches, to fit the opening in the centerpiece; the stationary packing rings in the centerpiece fit the spool of the piston, making it airtight. In operation the free air is drawn in at the ends of the air cylinders and is forced by the check valve into the annular spaces around the small diameter of the spool. From this space the air is forced into the main reservoir.

The pump has a normal capacity equal to that of the standard 11-inch pump which has been on the market for some years; but by compounding the air end, only an 8-inch steam cylinder is required. The steam consumption is thereby reduced to about 52 per cent of what the old 11-inch pump required. But this is not the whole of the gain, for, by compounding the air end, the capacity of the pump is increased about 16 per cent when pumped against 90 pounds pressure. This is due to the fact that the low-pressure clearance spaces at the end of compression stroke are filled with air at only 40 pounds pressure, instead of 90 pounds, as in the case in the simple pump. Hence the pressure of the clearance spaces reduces to atmospheric pressure much earlier in the intake stroke than is possible with the simple pump; consequently a larger volume of free air is drawn in at each stroke. From such tests as have been made, it appears that the new pump requires only 45 per cent of the steam per cubic foot of free air compressed that is required by the old 11-inch pump.

The operation of the steam end of the pump is the same as with standard 11-inch pump, but in the air end the operation is, of course, quite different. On, say, the down-stroke, air is drawn in through the strainer at the left through port *A* and inlet valve *B* to the upper pump chamber. The up-stroke of the piston compresses this air, forcing it through port *C*, lifting valve *D*, from whence it passes through port *E* and port *F* into the annular space around the spool piston. The second down-stroke of the piston further reduces the volume of air which has already been compressed to 40 pounds, and forces it at a pressure of 90 pounds, through port *G* and valve *H*, into the air discharge pipe leading to the main reservoir.

The action in the lower end of the pump is the same, air being drawn in through the air strainer at the right, but being discharged through the common discharge pipe *J*.



Figs. 1 and 2. Westinghouse Compound Air Pump.

STEEL CAGE BUILDING CONSTRUCTION.

The Tower Building on lower Broadway, which is claimed to be the first example of skeleton construction in which the entire weight of the walls and floors is borne and transmitted to the foundation by a framework of metallic posts and beams, is soon to be dismantled to make way for a larger building. It was erected in 1888-9 and was originated and designed by Architect B. L. Gilbert. Its frontage on Broadway is $21\frac{1}{2}$ feet and the height above the street 160 feet. If the ordinary system of building construction then in vogue had been employed, in which walls of stone or brick carried the entire weight, the available space on Broadway, after taking out the necessary thickness of the walls, would have been only a little more than 10 feet. Hence, in order to erect a profitable building it was positively necessary to invent a new method of supporting the walls other than had heretofore been employed. The result is what the world knows as the "steel cage" construction in which steel beams support the floors and the side walls, the stone or brick portion being merely a skin for filling in the open spaces. One of the strange sights of New York City is the erection of a modern office building, in which the upper floors are being completed first, while the lower floors stand gaunt and empty, the apparently slender steel beams supporting the enormous mass above it. In a recent issue of the *Times Engineering Supplement*, the claim of America being the birthplace of the steel cage construction is disputed, the Crystal Palace erected in London in 1851 being quoted as an early example of that type. The writer says that although the walls of the Crystal Palace happen to have been made of glass, it is easy to see that the architect (Paxton) could have designed any other building on the same system

with the skeleton perfectly capable of carrying a skin of sto or brick. The fact is, however, that he did not design suel building and there is nothing to show that he ever conceiv any such idea. It is not what men can do, but what they do that counts, and the fact that the English architect clos approached steel cage construction does not give Great Brita the right to claim its origin, especially as they never built a structures in which this idea was carried out prior to t Tower Building in New York. The writer bemoans the fa that steel cage construction did not come in vogue in t country in which he claims it originated, but the facts are th the modern office building was entirely impractical until t development of the elevator. It was useless to talk of bui ings six or seven stories high before the advent of the mode elevator, for no one, save, perhaps tenement dwellers, could induced to climb to such weary heights on any matter ordinary business, but with the coming of the elevator all w changed. The top floors then became the most desirable a the limits of high building construction were only marked the amount of capital that any builder was willing to put the construction of its foundations and superstructure. It presumable that thirty-story buildings will be as common New York ten years hence as fifteen-story buildings are the present time. In fact, with the enormous increase of la values, owners are being forced to build high buildings order to get adequate returns from their investments.

ALCOHOL AS A SOURCE OF POWER.

There is a certain tendency in British engineering circ says Mr. F. S. Lister in the *Times Engineering Supplem* to consider that the use of alcohol for a power medium internal combustion engines is still in its initial experimen stages, and that many very grave difficulties remain to overcome before it may take equal rank with the heavy light hydrocarbon oils as a source of power. There h been, no doubt, good reasons for this view, but to those w have given careful attention to the subject it is apparent t any difficulties arising are not really attributable to an herent defect in alcohol, or to a want of adaptability to requirements of the reciprocating engine, but are chiefly result of the restrictions imposed by law upon its use the prohibitive cost entailed by a high excise duty.

The development of the alcohol motor hitherto has b principally confined to Germany—where it has already established commercial position—and France. This is doubt owing to the fact that alcohol is cheaper than eit gas or petroleum; on the latter there is a restrictive duty 21 cents per gallon. Exhaustive tests were carried out in 1 on alcohol motors of different makes by the German Agri tural Society, which conclusively established its high effic cy. Tho Marienfeld motor showed an efficiency of 32.7 cent; others not much less. This is nearly double that of ordinary petroleum engines, for which 17 per cent may given as a fair average efficiency.

It will be useful, then, to compare the position of denatu alcohol with that of petroleum as regards its adaptability internal combustion engines. In the first place, the gasif tion of alcohol is much more difficult than that of petroleu it has therefore been found advisable to start the motor w benzine or petroleum and continue this until the temperat of the discharge gases reaches about 158 degrees F. This a disadvantage that is more apparent than real, and one, doubt, that will be overcome at a more advanced stage special devices. Again, the calorific value per unit weight only about half that of light petroleum oil. Consequently, obtain an equal explosive charge, double the weight of alcoh is required. This does not, however, indicate that, for a giv output of power, double the weight of alcohol is necessar as when alcohol is used the heat is more efficiently applie As we have already seen, the efficiency of the alcohol mot is much greater than that of the petrol motor. This is d to several reasons. The range of explosion of admixtures air and alcohol is very great, actually about twice that of p troleum vapor and air. As a result much more perfect com bustion of the fuel takes place, and it is possible to dispen with the exact valve regulation which is necessary when p troleum is used. The heavier alcohol requires less air, so th

ing in water. Suppose, for example, we take th pieces, heating at 1,830, 2,370 and 2,730 degrees F., or full orange, white and bright white respectively. We shall find that those at 2,370 and 2,730 degrees break very short and have lost nearly all their original tenacity, while that at 1,830 degrees appears tougher and altogether stronger than before.

Having arrived at a knowledge of the right temperature, it remains now to inquire as to the length of time requisite to yield a sufficient depth of case. At a full orange heat a bracket cup of ordinary dimensions should in two hours be hardened 1-32 inch deep, and a bracket axle 11-16 inch diameter in 6 hours would have a case 1-16 inch deep. From this it will be seen that the speed of penetration is not in exact proportion to the time of heating.

Why Hardening Without Reheating is Bad.

We now arrive at that part of the process where a most important improvement has been made—i. e., the final hardening by quenching in water. It formerly was customary at the end of the carbonizing period to open the pot and fling the contents headlong into a tank of cold water. Here and there some of the more careful workers took each article separately, but direct from the pot, and plunged it into water. These latter obtained better results, but even they had a great deal of trouble in the way of breakages and want of regular hardness. Finding that axles taken singly from the pot and quenched were better than those quenched in bulk, and that if allowed to cool down to cherry red they were better still, an application of the old rule to harden on a rising heat led to the now established principle of allowing the pot and its contents to become quite cold, afterward reheating to cherry red and quenching with water. By this means we obtain a case of great hardness with a very tough core—that is, of course, provided a suitable steel is employed.

To understand the reason of this improved method of working we must remember that the exterior of the steel is now of about 0.80 per cent carbon, and that steel of all kinds raised to and maintained at the high temperature employed for case-hardening will, unless subjected to mechanical work, show evidence of overheating, being very brittle and liable to easy fracture; and though quenched in water, and consequently hardened, the metal has little or no cohesion and readily wears away. Steel so hardened breaks with a very coarse crystalline fracture, in which the limits of the case are badly defined. It is known that when steel is gradually heated there is a certain point at which a great molecular change takes place, and that perfect hardness can only be obtained by quenching at this critical point. If quenching takes places below the critical temperature, the steel is not sufficiently hard; if above, though full hardness may be obtained, strength and tenacity are lost in part or completely, according as the critical temperature is exceeded by much or by little. This critical point lies between 1,380 and 1,470 degrees F., or cherry-red color heat. It may be asked why it is not sufficient, when taking the article out of the pot, to allow it to cool down to cherry red and then quench it. To this the answer is that the high temperature has already created a coarsely crystalline condition in the steel, and that until it has become quite cold and has again been heated up to the critical temperature, a suitable molecular condition cannot be obtained. When steel is cooled, whether slowly or not, it bears in its structure a condition representative of the highest heat it was last subjected to. From this it will be quite clear that in case-hardening as in all other methods of hardening, the steel must be quenched on a rising heat.

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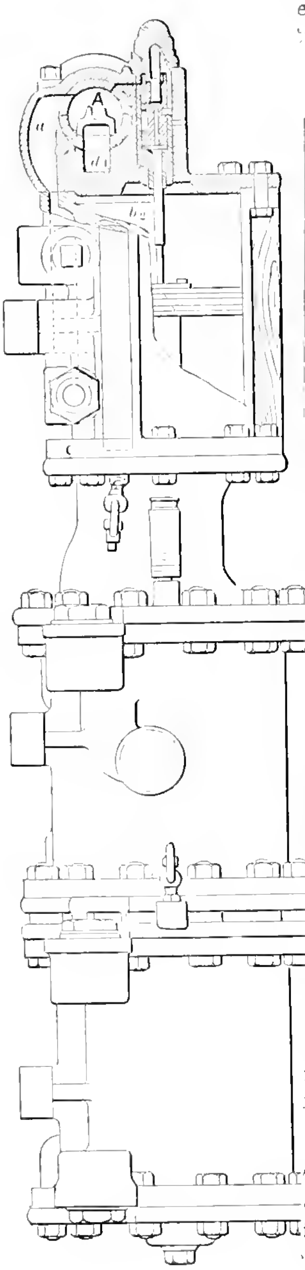
The Administrative County of London and District Electric Power Company is to construct three electric plants for generating current to supply the whole of London and some of the suburbs. Each plant is to consist of six turbo-generators each of 10,000 kilowatt normal and 20,000 maximum capacity. As these units are larger than any ever constructed the stations will be of unusual interest. Mr. C. E. L. Brown, of Brown, Boveri & Co., is the electrical expert chosen for the work. The Crocker-Wheeler Co., Ampere, N. J., are the American licensees of Brown, Boveri & Co., who act as consulting engineers for them on alternating current work, and they naturally feel a deep interest in the successful outcome.

WESTINGHOUSE COMPOUND AIR PUMP.

A new Westinghouse air pump of the compound type was exhibited at the Manhattan Beach convention of the American Railway Master Mechanics' Association, and a description of this pump showing its internal construction and method of operation was given by Mr. F. H. Parke, of the Westinghouse Air Brake Company, in a recent issue of *Railroad Gazette*. The new pump comprises three cylinders placed vertically in tandem; the upper cylinder is the steam cylinder and is 8 inches in diameter, having a stroke of 12 inches. The air cylinder end of the pump consists of two 11-inch cylinders joined by a short centerpiece having an 8¾-inch circular opening fitted with packing rings, as shown in the sectional view, Fig. 2. The air piston is spool-shaped, the ends being 11 inches in diameter and the small diameter of the spool being 8¾ inches, to fit the opening in the centerpiece; the stationary packing rings in the centerpiece fit the spool of the piston, making it airtight. In operation the free air is drawn in at the ends of the air cylinders and is forced by the check valve into the annular spaces around the small diameter of the spool. From this space the air is forced into the main reservoir.



The pump has a normal capacity equal to that of the standard 11-inch pump which has been on the market for some years; but by compounding the air end, only an 8-inch steam cylinder is required. The steam consumption is thereby reduced to about 52 per cent of what the old 11-inch pump required. But this is not the whole of the gain, for, by compounding the air end, the capacity of the pump is increased about 16 per cent when pumped against 90 pounds pressure. This is due to the fact that the low-pressure clearance spaces at the end of compression stroke are filled with air at only 40 pounds pressure, instead of 90 pounds, as in the case in the simple pump. Hence the pressure of the clearance spaces reduces to atmospheric pressure much earlier in the intake stroke than is possible with the simple pump; consequently a larger volume of free air is drawn in at each stroke. From such tests as have been made, it appears that the new pump requires only 45 per cent of the steam per cubic foot of free air compressed that is required by the old 11-inch pump.

The operation of the steam end of the pump is the same as with standard 11-inch pump, but in the air end the operation is, of course, quite different. On, say, the down-stroke, air is drawn in through the strainer at the left through port A and inlet valve B to the upper pump chamber. The upstroke of the piston compresses this air, forcing it through port C, lifting valve D, from whence it passes through port E and port F into the annular space around the spool piston. The second down-stroke of the piston further reduces the volume of air which has already been compressed to 40 pounds, and forces it at a pressure of 90 pounds, through port G and valve H, into the air discharge pipe leading to the main reservoir.

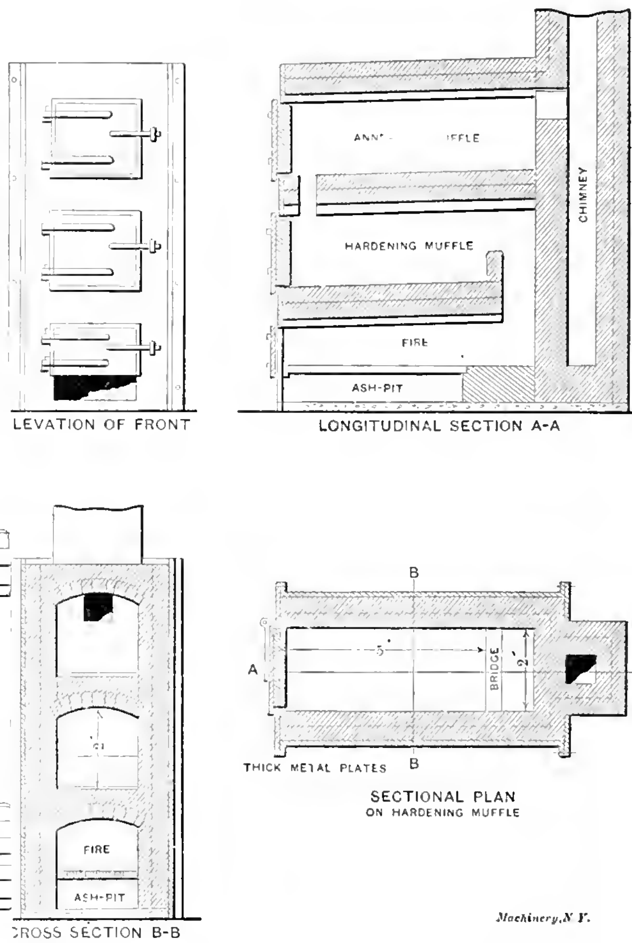
The action in the lower end of the pump is the same, air being drawn in through the air strainer at the right, but being discharged through the common discharge pipe J.

STEEL CAGE BUILDING CONSTRUCTION.

The Tower Building on lower Broadway, which is claimed to be the first example of skeleton construction in which the

Hardening pots are made in both cast and wrought iron, the former being cheaper in first cost, but the latter bear heating so many times that they are cheaper in the end. The pots should not be of too large dimensions, or there is great risk of articles in the middle of a charge not being carbonized to a sufficient depth. No pot should be above 18 by 12 by 11 inches for such articles as axles, pedal pins, and the like; while for small articles like cups, cones, etc., 12 by 8 by 8 inches is large enough. The pots should each have a plate-lid fitting closely inside.

The carbonizers in general use at the present day are animal charcoal, bones, and one or two other compositions sold under various names, and consisting of mixtures of carbonaceous matter and certain cyanides or nitrates. For very slight hardening, cyanides alone are still found very useful, but no great depth of casing is ever attempted with these. Theoretically, the perfect carbonizer should be a simple and pure



Plan and Elevation of Flather Casehardening Furnace.

form of carbon, and good charred leather gives the most certain and satisfactory results. Care should be taken to avoid poorly charred leather or that made from old boots, belting, etc.

Clay.

As clay must be used for a luting round the pot lid, and is also frequently used for stopping off portions to be left soft, it is important to see that a good clay is used, and that it is free from grease. Clay contaminated with grease in any way will cause irregularity in the product.

Reheating Muffles.

As all casehardened articles have to be reheated before quenching, it is important that a suitable furnace should be employed for the purpose. It is not advisable that the reheating should be done in the casehardening muffle, unless it is run specially for the purpose and at a lower heat. If possible a small gas muffle should be used for reheating, and indeed for all hardening work. A properly-constructed gas muffle can be regulated with great exactness, and this is very important in all hardening.

Packing the Muffles.

The carbonizer having been thoroughly dried and reduced to a fine powder, a layer of not less than 1½ inch in depth

is placed in the hardening pot and well pressed down. Upon this are placed the articles to be hardened. Care must be taken to leave sufficient space all round each piece to prevent its touching the others or the walls of the pot; a space of 1½ inch should be sufficient. Another layer of carbonizer is then put in and well pressed down, taking care not to displace any of the articles already packed, continuing until the pot is nearly full, and then finishing off with another layer of 1½ inch at the top. The object in view must be to make the contents of the pot as compact as possible, consistent with a sufficiency of carbonizer in contact with the articles. The more solidly a pot is packed the more effectual is the exclusion of air. The lid is then put on, and the joint all round well luted with clay. By the time the proper number of pots has been filled, the furnace must have been raised steadily to the full working heat.

Furnace Heat.

The proper heat for casehardening is about 1,800 degrees F., or a full orange heat and this should be maintained with great regularity throughout the operation. The length of time occupied in carbonizing is regulated by the depth of casing required, and indirectly by the dimensions of the article. At the close of the carbonizing period the pot is withdrawn from the furnace and placed in a dry place, where it is allowed to become quite cold. It is then opened, the articles taken out and brushed over to remove all adhering matter. If the pot has been properly packed, and luted up, the articles should be quite white, or at least have only a slight film or bloom of a deep blue color; the denser and more inclined to redness is the surface, the more imperfect has been the packing and sealing of the pot.

Reheating and Hardening.

The carbonized articles are now placed in a muffle furnace and steadily raised to a good cherry red (1,470 degrees F.), and then quenched in cold or tepid water or oil, according to the purpose of the articles required. They should remain in the cooling liquid until they are quite cold right through the body of the metal, thus completing the process.

Although the proper temperature for casehardening is about 1,830 degrees F., this temperature may be modified to suit the purpose in view. The absorption of the carbon commences when the steel reaches a low cherry-red heat (1,300 degrees F.); it begins, of course, at the outer surface and gradually spreads until the whole of the steel is carbonized. The length of time this requires depends upon the thickness of the metal being treated. The percentage of carbon absorbed is governed by the temperature, and although the increase of carbon is not in uniform proportion to the rising temperature throughout, it is perhaps sufficient for our present purpose to note that at 1,300 degrees F. iron, if completely saturated, can contain no more than about 0.50 per cent carbon; at 1,650 degrees F., about 1.5 per cent carbon; and 2,000 degrees F., about 2.5 per cent. These results, however, are only obtained when the whole section of the iron has received all the carbon it is capable of absorbing at the given temperature, and is therefore in a state of equilibrium. From this it will be seen that if the process is stopped before the action is complete, the central parts of the iron must contain less carbon than the outside, and upon this fact the process of casehardening is founded.

If we take two pieces of ⅝ inch diameter round mild steel, and heat one of them with a carbonizer at a cherry-red heat, and the other at a bright orange heat, for six hours, the first will be cased to a depth of about 1-32 inch, and the other to a depth of nearly 1-16 inch, while the amount of carbon taken up will be about 0.50 and 0.80 per cent respectively. So that, so far as regards the hardness of the skin, the piece carbonized at the higher temperature gives the best result. From this we learn that a temperature of 1,830 degrees F. will give us sufficient hardness of case.

We have next to find which temperature has the least hurtful effect on the mild steel core, and this can best be found by heating pieces of the mild steel at varying temperatures at and above the selected one for the same length of time, using lime or other inert substance in the pot instead of a carbonizing material, and afterward reheating and quenching in water. Suppose, for example, we take three pieces, heating at 1,830, 2,370 and 2,730 degrees F., or full orange, white and bright white respectively. We shall find that those at 2,370 and 2,730 degrees break very short and have lost nearly all their original tenacity, while that at 1,830 degrees appears tougher and altogether stronger than before.

Having arrived at a knowledge of the right temperature, it remains now to inquire as to the length of time requisite to yield a sufficient depth of case. At a full orange heat a bracket cup of ordinary dimensions should in two hours be hardened 1-32 inch deep, and a bracket axle 11-16 inch diameter in 6 hours would have a case 1-16 inch deep. From this it will be seen that the speed of penetration is not in exact proportion to the time of heating.

Why Hardening Without Reheating is Bad.

We now arrive at that part of the process where a most important improvement has been made—i. e., the final hardening by quenching in water. It formerly was customary at the end of the carbonizing period to open the pot and fling the contents headlong into a tank of cold water. Here and there some of the more careful workers took each article separately, but direct from the pot, and plunged it into water. These latter obtained better results, but even they had a great deal of trouble in the way of breakages and want of regular hardness. Finding that axles taken singly from the pot and quenched were better than those quenched in bulk, and that if allowed to cool down to cherry red they were better still, an application of the old rule to harden on a rising heat led to the now established principle of allowing the pot and its contents to become quite cold, afterward reheating to cherry red and quenching with water. By this means we obtain a case of great hardness with a very tough core—that is, of course, provided a suitable steel is employed.

To understand the reason of this improved method of working we must remember that the exterior of the steel is now of about 0.80 per cent carbon, and that steel of all kinds raised to and maintained at the high temperature employed for casehardening will, unless subjected to mechanical work, show evidence of overheating, being very brittle and liable to easy fracture; and though quenched in water, and consequently hardened, the metal has little or no cohesion and readily wears away. Steel so hardened breaks with a very coarse crystalline fracture, in which the limits of the case are badly defined. It is known that when steel is gradually heated there is a certain point at which a great molecular change takes place, and that perfect hardness can only be obtained by quenching at this critical point. If quenching takes places below the critical temperature, the steel is not sufficiently hard; if above, though full hardness may be obtained, strength and tenacity are lost in part or completely, according as the critical temperature is exceeded by much or by little. This critical point lies between 1,380 and 1,470 degrees F., or cherry-red color heat. It may be asked why it is not sufficient, when taking the article out of the pot, to allow it to cool down to cherry red and then quench it. To this the answer is that the high temperature has already created a coarsely crystalline condition in the steel, and that until it has become quite cold and has again been heated up to the critical temperature, a suitable molecular condition cannot be obtained. When steel is cooled, whether slowly or not, it bears in its structure a condition representative of the highest heat it was last subjected to. From this it will be quite clear that in casehardening as in all other methods of hardening, the steel must be quenched on a rising heat.

* * *

The Administrative County of London and District Electric Power Company is to construct three electric plants for generating current to supply the whole of London and some of the suburbs. Each plant is to consist of six turbo generators each of 10,000 kilowatt normal and 20,000 maximum capacity. As these units are larger than any ever constructed the stations will be of unusual interest. Mr. C. E. L. Brown, of Brown, Boveri & Co., is the electrical expert chosen for the work. The Crocker-Wheeler Co., Ampere, N. J., are the American licensees of Brown, Boveri & Co., who act as consulting engineers for them on alternating current work, and they naturally feel a deep interest in the successful outcome.

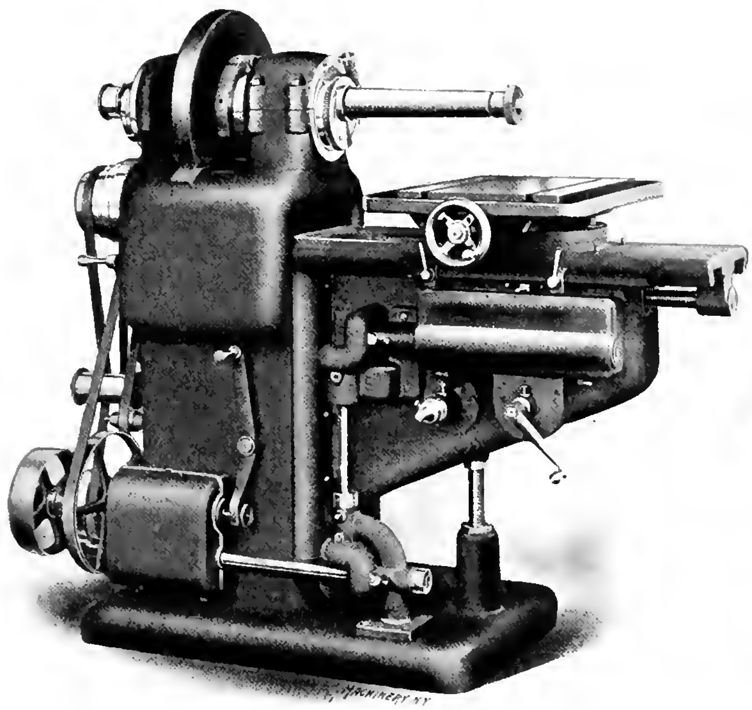
HEALD CYLINDER GRINDER.

This machine has been developed for the accurate finishing of gas and gasoline engine cylinders, and internal grinding of parts which are of such shape that it is impracticable to rotate them. It is intended to meet the demand for a better method of finishing the interior of engine cylinders than that heretofore employed. In the construction of automobile engines, epecially, the walls are necessarily thin and when the surface is finished by boring or reaming there is a continual tendency on the part of the iron to spring away from the cutting tool. If there are hard and soft spots in the iron, it is almost impossible to have the boring tools cut a perfectly round hole, as the iron in this thin shell will spring away from the tool and come back again after the tool has passed on. With grinding, however, this is not the case, because there is not the pressure against the walls of the cylinder with the grinding wheel that there is with a boring tool, especially when sharp and free cutting wheels are used. The character of the surface also is, for reasons readily understood, far more perfect than can be obtained by boring or reaming.

The machine illustrated by the accompanying cut consists of a main frame or column carrying a grinding spindle which revolves about a horizontal axis. This grinding spindle is mounted in double eccentrics, thus giving a sort of a planetary motion to the spindle and grinding wheel, and making an effective device for getting the correct diameter of the holes and insuring their being perfectly round. Eight different speeds of rotation are given to the eccentrics to handle work of different diameters and conditions. The wheel spindle runs in bronze boxes, provided with a simple adjustment for wear. The end of the wheel spindle is made tapering to receive wheels mounted on collets, thus allowing wheels to be changed without delay in truing up. Provision is also made for feeding out the wheel to regulate the depth of the cut, while the machine is in motion.

On the front of the column is a knee, carrying the main sliding table, which travels back and forth in a line parallel to the grinding spindle. On the top of this table is a cross slide table for giving crosswise adjustment. In the operation of this machine the work does not rotate but is held in position by means of jigs or other fixtures on the table of the machine, which is a convenient method of handling work when it is large or out of balance so that it is not easy to rotate it. This method of handling also makes it possible to grind duplex cylinders as readily as single cylinders, an advantage that will be greatly appreciated. By means of the vertical adjustment of the knee on the column and the crosswise movement of this upper table any adjustment of the work can be obtained, either to bring a single hole in line with the grinding spindle or to transfer the work from one hole to another, as is necessary when duplex cylinders are to be ground. The travel of the table is automatic, reversing accurately at any point desired. The rate of traverse is controlled by a change-gear box on the column of the machine, giving three different rates of feed to the table.

This machine will finish holes up to 8 inches diameter by 15 inches long. It is built by the Heald Machine Co., Station D-2, Worcester, Mass.



Heald Clyinder Grinder.

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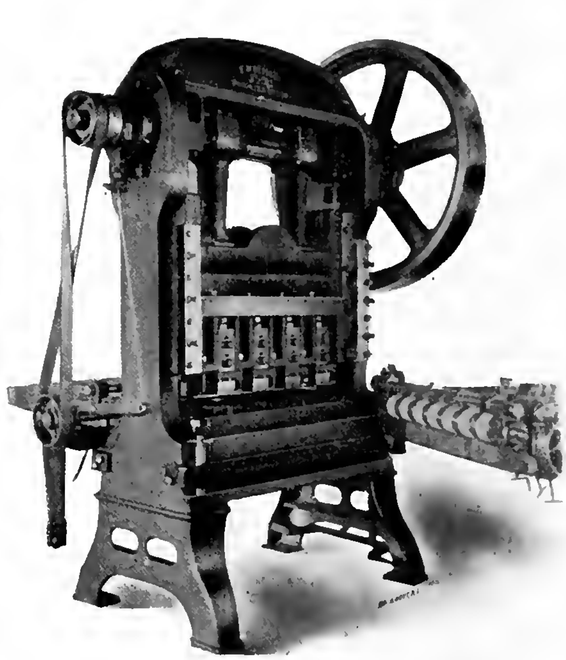
BLISS PRESS WITH SPECIAL FEED.

In the accompanying half-tones we show a press with an interesting feed, which is specially adapted for handling cardboard, although it may be used for other purposes. This feed consists of two pairs of rolls in front and back of the machine, driven by belts connected with pulleys on the main shaft, and in addition to this there is a belt feed as shown, used for carrying the stock up to and away from the gripping rolls. The tables over which the canvas belts move are so arranged that they may be swung out of the way to give the operator free access to the dies for the purpose of adjusting them. These tables extend about 4 feet both in front and back of the press, and are wide enough to handle sheets of cardboard up to 40 inches. Gages are fitted to the tables so that the narrower sheets may be used when desired. The press is also fitted with adjustable automatic stop fingers to hold the paper in place while being cut. There is no adjustment on the pitmans, bnt the press is equipped with nine separately adjustable punch holders.



Bliss Press with Special Feed

Some of the principal dimensions of this machine are as follows: Width between uprights, 44 inches; distance between gibs, 38 inches; weight of balance wheel, 1,300 pounds; total weight of machine, 13,000 pounds. The press is built by E. W. Bliss Co., No. 5 Adams Street, Brooklyn, N. Y.

* * *

The Republic Engineering Company, Pittsburg, Pa., is making a new shaft coupling which has some decidedly novel points. The gripping element is in the form of a coiled spring. This is enclosed in a cast-iron cylindrical casing and is wrapped tightly around the ends of the two shafts by means of nuts threaded on its ends. It has no projecting parts to make it dangerous; it will couple shafts which vary slightly in diameter and will increase its grip as the load which it transmits is increased.

THERMIT WELDING LOCOMOTIVE FRAMES.

Not the least interesting feature of the recent Manhattan Beach Convention of the American Railway Master Mechanics' Association was the daily demonstration of the Goldschmidt Thermit Company, in welding heavy pieces of wrought iron, representing a broken locomotive frame, by the thermit process. The pieces were 3 x 4 inches and were fixed in a mold of the character shown in Fig. 1. When all was ready, the reaction in the crucible and the pouring of the metal making the weld, occupied the time of perhaps one minute. The demonstrations, which took place in a sand lot near the Oriental Hotel, were a conclusive proof to those who assembled of the remarkable power of thermit for welding locomotive frames and similar parts. The fact that frames may be welded *in situ* makes the process one of great value in locomotive repair work, inasmuch as the labor necessary to remove a broken frame and carry it to the blacksmith shop is generally more than the actual work of repair.

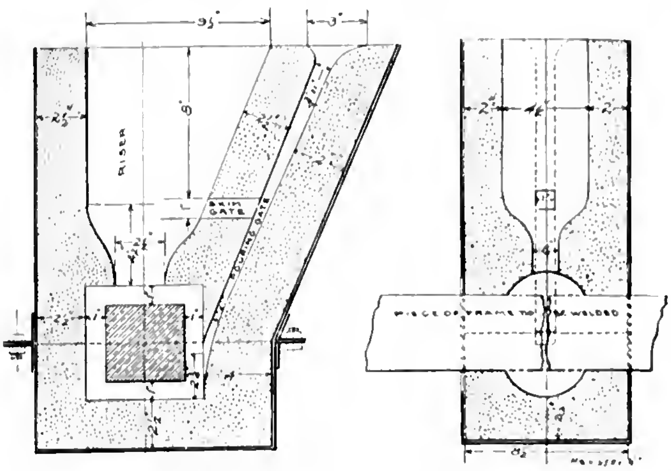


Fig. 1. Section through Mold which is Built around the Part to be Repaired

The accompanying half-tone, Fig. 2, shows the set-up of a thermit crucible for welding a broken locomotive frame in the Collinwood shops of the Lake Shore & Michigan Southern Railway; and Fig. 3 shows the welded frame with the slag riser remaining on top. It will be noted that the metal forming the weld, makes a collar around the frame about ½ or ¾ inch high. Where this projection does not interfere, it is left in place in order to make a thoroughly strong job. Fig. 4 shows the welding of the broken spokes of a locomotive driving wheel in the Elkhart shops of the same road. The ordinary method of igniting the thermit is by means of a special igniting powder supplied for the purpose, but in the Elkhart shops an electric spark is employed instead.

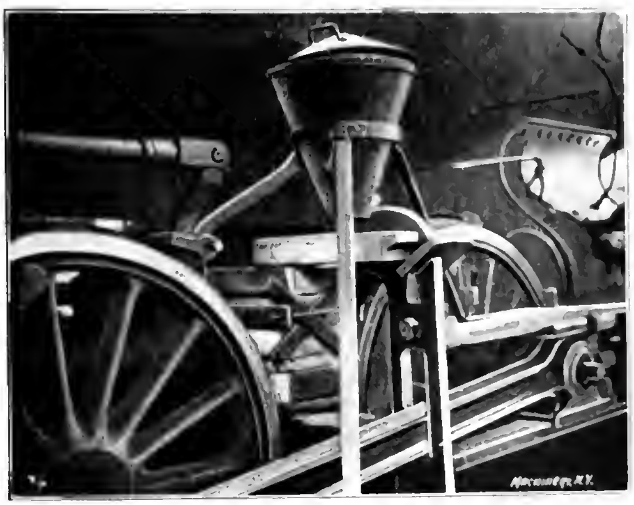


Fig. 2. Crucible in place over Mold, ready for Ignition and Pouring

In welding a locomotive frame, or any other broken part, the fracture must be opened sufficiently to allow the molten thermit to enter in the break. This may be done by pulling or springing the frame apart so as to leave, say, ⅜ or ½ inch clear space throughout the crack, or a [illegible] may be drilled in the crack to accomplish the same purpose. When the frame is sprung apart, the pressure is released [illegible] seconds after the thermit has flowed, so that the parts [illegible]

Fig. 3. Repaired Fracture after Removal of Flask, showing Slag Riser

assume their proper relation before the metal sets. It is customary to tram the frame across the break and to allow about 3/16 inch for shrinkage.

About 60 to 75 pounds of thermit will weld a 4 x 5 inch section; but this quantity may be reduced about 20 per cent by adding iron punchings at the rate of one pound of punchings in place of two pounds of thermit. Thus, instead of using 75 pounds of thermit, 60 pounds may be used and 7½ pounds of punchings. In making any weld, however, the space to be

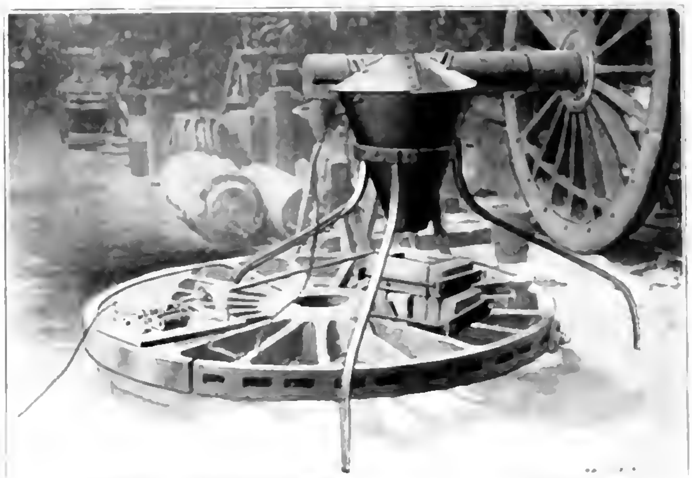


Fig. 4. Crucible, Mold, and Ignition Apparatus ready for the Repair of a Broken Driving Wheel Spoke

filled with the molten metal can be carefully measured and its volume computed. Since 9½ ounces of thermit make about 1 cubic inch of steel, it follows that there will be required as many ounces of thermit as there are cubic inches in the weld times 9½.

* * *

When the mica insulation between commutator bars becomes burned down by sparking until it is below the level of the bars, short circuits between adjacent bars become a source of trouble. It is claimed that the commutator in which the mica insulation has been burned away so as to permit the accumulation of carbon dust can be permanently repaired by digging out all the dirt and burnt mica and filling in the cavities with thin paste of litharge and glycerin. After filling, the paste is baked with a soldering iron or blow pipe into a hard compound which may be filed off smooth and even with the commutator's surface. The litharge and glycerin should be thoroughly ground together when used as a cement, as the intimate mixture of the parts is very necessary to secure the best results. Litharge and glycerin cement is also used for setting glass plates in metal frames.

PROPORTIONS OF TWIST DRILLS.

H. D.

The following is a set of empirical formulas and tables for the proportions of twist drills. The lack of uniformity of the main dimensions of such drills, even when manufactured for the market, has been noted in many instances, and the following is an attempt to systematize the proportions of same, giving proper dimensions at the same time as insuring uniformity.

The dimensions referred to above, and for which formulas are provided are, the total length, and the length of the grooved portion. In order to establish uniformity in regard to the total lengths, taper shank and straight shank drills ought to have the same total lengths. As the length of the taper shank always must be some "standard" (usually and preferably Morse standard taper) formulas are not given for the lengths of grooved parts on taper shank drills, as these lengths will, when the total length is given, depend entirely upon the length of the Standard taper used. It is obvious that after the length of the taper shank is deducted from the total length, the remaining portion will be grooved as far up towards the taper shank as practicable. For straight shank drills, however, a formula is given which provides for well proportioned lengths of shank and grooved portion.

As the angle of helix of a twist drill is one of the most important factors influencing its cutting qualities, the lead must be chosen so as to give a proper angle between the direction of the groove and the center line of the drill. This angle will be 24° 10′ if the lead given by the formula is used. It is obvious that every lead given in the table cannot be obtained on every universal milling machine, but in cases where this trouble is met with it is preferable to use the nearest larger lead for drills made of some kind of high speed steel, and the nearest lower lead for drills that are made out of common tool steel.

TABLE I. MAIN DIMENSIONS OF TWIST DRILLS

Diameter.	Total Length.	Length of Groove on Straight Shank Drills.	No. of Morse Taper on Morse Taper Shank Drills.	Lead of Grooves.
3	21	15	5	21
2 15/16	20 3/4	14 13/16	5	20 9/16
2 7/8	20 1/2	14 5/8	5	20 1/8
2 13/16	20 1/4	14 7/16	5	19 11/16
2 3/4	20	14 1/4	5	19 1/4
2 11/16	19 3/4	14 1/16	5	18 13/16
2 5/8	19 1/2	13 7/8	5	18 3/8
2 9/16	19 1/4	13 11/16	5	17 15/16
2 1/2	19	13 1/2	5	17 1/2
2 7/16	18 3/4	13 5/16	5	17 1/16
2 3/8	18 1/2	13 1/8	5	16 5/8
2 5/16	18 1/4	12 15/16	5	16 3/16
2 1/4	18	12 3/4	5	15 3/4
2 3/16	17 3/4	12 9/16	5	15 5/16
2 1/8	17 1/2	12 3/8	5	14 7/8
2 1/16	17 1/4	12 3/16	5	14 7/16
2	17	12	4	14
1 15/16	16 5/8	11 3/4	4	13 9/16
1 7/8	16 1/4	11 7/16	4	13 1/8
1 13/16	15 7/8	11 3/16	4	12 11/16
1 3/4	15 1/2	10 7/8	4	12 1/4
1 11/16	15 1/8	10 5/8	4	11 13/16
1 5/8	14 3/4	10 5/16	4	11 3/8
1 9/16	14 3/8	10 1/16	4	10 15/16
1 1/2	14	9 3/4	4	10 1/2
1 7/16	13 5/8	9 1/2	4	10 1/16
1 3/8	13 1/4	9 3/16	4	9 5/8
1 5/16	12 7/8	8 15/16	4	9 3/16
1 1/4	12 1/2	8 5/8	3	8 3/4
1 3/16	12 1/8	8 3/8	3	8 5/16
1 1/8	11 3/4	8 1/16	3	7 7/8
1 1/16	11 3/8	7 3/4	3	7 7/16
1	11	7 1/2	3	7
15/16	10 5/8	7 3/16	3	6 9/16
7/8	10 1/4	6 15/16	2	6 1/8
13/16	9 7/8	6 5/8	2	5 11/16
3/4	9 1/2	6 3/8	2	5 1/4
11/16	9 1/8	6 1/16	2	4 13/16
5/8	8 3/4	5 13/16	2	4 3/8
9/16	8 3/8	5 1/2	1	3 15/16
1/2	8	5 1/4	1	3 1/2
7/16	7 5/8	4 15/16	1	3 1/16
3/8	7 1/4	4 11/16	1	2 5/8
5/16	6 7/8	4 3/8	1	2 3/16
1/4	6 1/2	4 1/8	1	1 3/4

TABLE II. MAIN DIMENSIONS, WIRE GAGE SIZES, TWIST DRILLS.

No. of Steel Wire Gage.	Diameter in inches.	Total Length.	Length of Groove.	Lead of Grooves
1	.2280	4	2 3/4	1 5/8
2	.2210	3 15/16	2 11/16	1 9/16
3	.2130	3 7/8	2 5/8	1 1/2
4	.2090	3 13/16	2 9/16	1 7/16
5	.2055	3 3/4	2 1/2	1 7/16
6	.2040	3 3/4	2 1/2	1 7/16
7	.2010	3 3/4	2 1/2	1 7/16
8	.1990	3 11/16	2 7/16	1 3/8
9	.1960	3 11/16	2 7/16	1 3/8
10	.1935	3 5/8	2 3/8	1 3/8
11	.1910	3 5/8	2 3/8	1 5/16
12	.1890	3 9/16	2 5/16	1 5/16
13	.1850	3 9/16	2 5/16	1 5/16
14	.1820	3 1/2	2 1/4	1 1/4
15	.1800	3 1/2	2 1/4	1 1/4
16	.1770	3 7/16	2 3/16	1 1/4
17	.1730	3 3/8	2 1/8	1 3/16
18	.1695	3 3/8	2 1/8	1 3/16
19	.1660	3 5/16	2 1/16	1 3/16
20	.1610	3 1/4	2	1 1/8
21	.1590	3 1/4	2	1 1/8
22	.1570	3 1/4	2	1 1/8
23	.1540	3 3/16	1 15/16	1 1/16
24	.1520	3 3/16	1 15/16	1 1/16
25	.1495	3 1/8	1 7/8	1 1/16
26	.1470	3 1/8	1 7/8	1
27	.1440	3 1/16	1 13/16	1
28	.1405	3 1/16	1 13/16	1
29	.1360	3	1 3/4	15/16
30	.1285	2 15/16	1 11/16	7/8
31	.1200	2 13/16	1 9/16	13/16
32	.1160	2 3/4	1 1/2	13/16
33	.1130	2 3/4	1 1/2	13/16
34	.1110	2 3/4	1 1/2	3/4
35	.1100	2 11/16	1 7/16	3/4
36	.1065	2 11/16	1 7/16	3/4
37	.1040	2 5/8	1 3/8	3/4
38	.1015	2 5/8	1 3/8	11/16
39	.0995	2 9/16	1 5/16	11/16
40	.0980	2 9/16	1 5/16	11/16
41	.0960	2 3/8	1 3/16	11/16
42	.0935	2 5/16	1 3/16	5/8
43	.0890	2 1/4	1 1/8	5/8
44	.0860	2 1/4	1 1/8	5/8
45	.0820	2 3/16	1 1/16	9/16
46	.0810	2 3/16	1 1/16	9/16
47	.0785	2 1/8	1 1/16	9/16
48	.0760	2 1/8	1	9/16
49	.0730	2 1/16	1	1/2
50	.0700	2	15/16	1/2
51	.0670	2	15/16	1/2
52	.0635	1 15/16	7/8	7/16
53	.0595	1 7/8	7/8	7/16
54	.0550	1 7/8	13/16	3/8
55	.0520	1 13/16	3/4	3/8
56	.0465	1 3/4	11/16	5/16
57	.0430	1 11/16	11/16	5/16
58	.0420	1 11/16	11/16	5/16
59	.0410	1 11/16	11/16	5/16
60	.0400	1 11/16	5/8	5/16

As Morse standard taper shanks are the most commonly used on drills, a column is given in the table showing for what size drills different sizes of Morse tapers should be used. Taper shanks are not used on any drills smaller than 1/4-inch diameter.

Dimensions given in Tables I. and II. are figured from the formulas, and when the result has been an uneven fraction of an inch, the result has been given in the nearest sixteenth.

L = total length.

G = length of grooved part.

D = diameter of drill.

S = lead.

For the lead of grooves the formula

$$S = 7 \times D$$

should be applied on all sizes.

For the total length:

1. From 3 inches diameter to 2 1-16 inches diameter

$$L = 4 \times D + 9 \text{ inches.}$$

2. From 2 inches diameter to 1/4 inch diameter

$$L = 6 \times D + 5 \text{ inches.}$$

3. From No. 1 to No. 40 steel wire gage
$$L = 11 \times D + 1\frac{1}{2} \text{ inches.}$$
4. From No. 41 to No. 60 steel wire gage
$$L = 12 \times D + 1\text{ 3-16 inches.}$$

For the length of grooved parts:

1. From 3 inches diameter to 2 1-16 inches diameter
$$G = 3 \times D + 6 \text{ inches.}$$
2. From 2 inches diameter to ¼-inch diameter
$$G = 4\frac{1}{2} \times D + 3 \text{ inches.}$$
3. From No. 1 to No. 40 steel wire gage
$$G = 11 \times D + \frac{1}{4} \text{ inch.}$$
4. From No. 41 to No. 60 steel wire gage
$$G = 10 \times D + \frac{1}{4} \text{ inch.}$$

In connection with the data above it might be proper to add a few general remarks in regard to twist drills.

The keenness and durability of the cutting edge depend upon three main factors, viz.: 1. The clearance given to the cutting edge by grinding. 2. The angle of one cutting edge to the other, and 3. The degree of twist of the groove, *i. e.*, the lead.

It is obvious that the speed of the various points of the cutting edge is different according to the distance from the center; hence, the cutting point at the corner operates at the highest rate of cutting speed, and thus performs the heaviest duty. Therefore the angle of clearance should be so selected that this corner is given the most desirable angle for durability. The keenness of the corner also depends upon the angle of the cutting edges with the center line; most manufacturers make this angle 60 degrees, some—amongst them Morse Twist Drill & Machine Co.—59 degrees. However, different angles will be found more suitable for different metals; thus, a drill for brass will cut more satisfactory with an angle of 45 degrees between the cutting edges and the center line.

It will be noted that only one lead is given for the groove in the formulas above ($7 \times$ diameter). This lead will be found satisfactory for all ordinary conditions. However, it is desirable on twist drills running at a very high speed to increase the lead somewhat. If for some reason or other a drill has to be used at a slower speed than ordinary, better results will be obtained by a slight decrease in the lead.

It is a well-known fact that at present all twist drills are made with two flutes, but twist drills having three or more flutes have been devised, made, and tried. The advantage gained by adding to the number of cutting edges has, however, not been great enough to justify the increased cost of manufacture. When added to this comes the weakness caused by the increased number of grooves, and the complicated operation of correctly grinding such drills, it is clear why drills having two flutes only have been and should be adopted.

• • •

LINK MILLING ATTACHMENT.

The Warner Instrument Co., Beloit, Wis., manufacture an instrument, called an auto-meter, for indicating in direct reading the speed in miles per hour at which a motor car is traveling at any moment. The device works on the same general principle as the cut-meter made by the same concern for indicating the working speed of lathes, planers and other machine tools, but motion is conveyed to it differently, the instrument being driven from the front wheel by a flexible shaft of simple and interesting construction. The sketch, Fig. 1, shows the scheme of flexible shaft construction. The links *A* are pieces

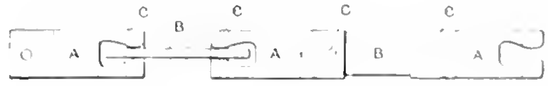


Fig. 1. Simple Flexible Shaft, used for Connecting "Auto-meter" with Wheel of Automobile

of round steel rod cut to length and having a dovetail slot milled in each end, but in planes at right angles to each other. The links *B* are merely flat steel pieces which loosely fit in between the jaws of the round links formed by the dovetail slots; the round and flat links are held together with rivets, *C*, which loosely fit in *B*.

The milling of the dovetail slots in the round links is accomplished with a simple attachment for a hand milling machine designed by Mr. Cadman, the shop superintendent. Perhaps the most interesting feature of the device, which is shown in Fig. 3, is that it works without causing many saw breakages, inasmuch as the saw is required to cut a slot wider than the saw's thickness at the bottom but of the same width at the top. It is one example of many surprising things that have become feasible with the advent of high-speed steel. The link in which the dovetail slot is to be cut, is held in an oscil-


Fig. 2 Links of Flexible Shaft, showing Cut made by Milling Attachment

lating vise, and is fed against a cutter or slitting saw made of high-speed steel, running at a peripheral speed of about 250 feet per minute. As the link passes under the saw its oscillatory movement causes the bottom of the slot to be cut to a greater width than the top, the axis of oscillation being through the end of the link and at right angles to it, and parallel with the plane of the saw. With the saw running at

Fig. 3 Attachment for Milling Dovetail Slots in Links shown in Fig. 2

a peripheral speed of 250 feet per minute and the links oscillated at the rate of 150 times per minute the operator is able to mill about 1,000 slots or 500 links per day.

• • •

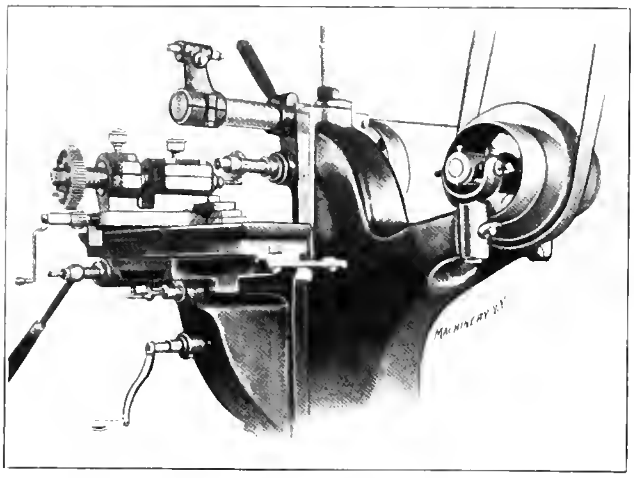
In an address delivered by Captain O. C. Horney of the Watervliet Arsenal, before the Young Men's Christian Association, on the subject of gunpowder and projectiles, note was made of the enormous pressure developed in modern guns. The pressure developed by a full powder charge on the nose of a breech-block of a 12-inch gun is something like 4,000,000 pounds; on that of a 16-inch gun the pressure is 11,000,000 to 12,000,000 pounds. To make these figures more impressive, especially the latter, it might be added that when the 16-inch gun (of which the United States possesses only one), is fired, the breech-block sustains a pressure greater than the ultimate tensile strength of mild steel bar 14 inches square.

ITEMS OF MECHANICAL INTEREST.

MILLING SQUARE THREAD SCREWS.

The cut shows an attachment for a Whitney hand milling machine which is used in the shop of the George Gorton Machine Company, Racine, Wis., for milling square thread screws, used in the adjustment of an engraving machine spindle. The screw has the approximate dimensions of 1 1-32 inch length, ½-inch diameter over top of thread, 7-16-inch diameter at bottom of thread, lead 5-16 inch, width of land 3-32 inch, width of groove 7-32 inch, diameter hole ¼ inch.

The attachment is a simple device consisting of a casting with two bearings, one of which is bored for a nut and the other to the outside diameter of the lead screw. A gear is

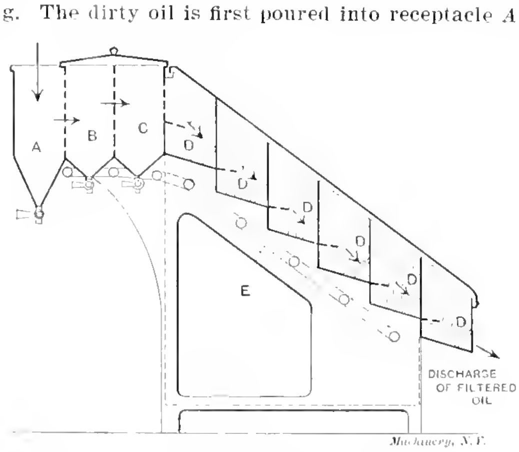


Attachment for Milling Square Threads on Whitney Hand Miller.

mounted on the outer end of the lead screw, and with it is meshed a pinion which is operated by hand. The opposite end of the lead screw terminates in a small spindle on which is mounted the blank to be milled. The attachment is swiveled on the milling machine table to the proper angle and the operator feeds the device slowly against the cutter until the gear brings up against a stop. The thread, of course, is not exactly square, but is a close approximation of it, being so nearly square that a sample would readily pass as a square thread screw were it not known that the thread was milled. The fact that the thread is milled precludes the possibility of its being square, as a square thread screw, of course, cannot be milled with the ordinary type of axial milling cutter.

GERMAN OIL FILTER.

An oil filter of rather novel construction is described by Ernest L. Harris, U. S. Commercial Agent at Eibenstock, Germany, in a recent consular report, of which a sectional view is shown in the accompanying cut, to illustrate the method of working. The dirty oil is first poured into receptacle *A*, where



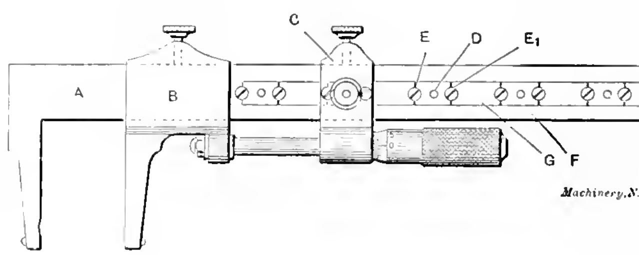
German Oil Filter.

the heavy impurities sink to the bottom from whence they may be drawn off through the faucet at the bottom. The same process takes place progressively in chambers *B* and *C*, by which time the greater portion of the heavy impurities has been deposited so that all that remains to be removed of the filtering material is that having practically the same specific gravity as the oil. These impurities are removed in passing through a series of filtering troughs *D* situated on an inclined plane. The filtering troughs have a removable cover, which construction allows the filtering material to be conveniently examined and changed, and permits any particular filtering chamber to be changed independently of the others.

Although it is not so specifically stated in the consular report, it appears from the cut that a pipe coil *E* is provided underneath the settling and filtering chambers for warming the oil. This is a very necessary feature of any oil filter, as in cold weather the dirty oil becomes very thick and heavy, and it filters very slowly or not at all until warmed up to 100 degrees or more.

IMPROVED MICROMETER BEAM CALIPER.

In a beam caliper having a sliding micrometer jaw with or without a separate clamping slide, it is necessary to have the beam divided into unit spaces, at which the jaw or slide may be accurately fixed, the micrometer screw then being used to cover the distance between the divisions. But it is difficult to construct a beam caliper of this type with holes for a taper setting pin, at exactly equal distances apart; consequently a plan that is generally followed in making such tools is to provide as many holes through the slide and beam as there are inch divisions, each hole being drilled and reamed through both the slide and beam at once. If it were attempted to drill the holes through the beam at exactly one inch apart, having only one hole in the clamping head and using it as a jig for the purpose, it would be found very difficult, if not impossible, to get the holes all of one size and exactly one



Improved Micrometer Beam Caliper.

inch apart. The design of the micrometer beam caliper shown in the accompanying cut, which was patented by Mr. Frank Spalding, Providence, Rhode Island, is such, however, that it is not necessary to drill more than one hole through the clamping slide. The beam, *F*, is grooved longitudinally and in the groove are fitted hardened steel adjusting blocks in which a taper hole, *D*, is accurately finished. Between the blocks, *E*, are filling pieces, *G*, which are brazed or otherwise fastened in the groove. Holes are drilled, tapped and countersunk between the blocks and the filling pieces *G*, in which are fitted taper head screws, E E_1. The construction is thus obviously such that the blocks may be shifted longitudinally by loosening one screw and tightening the other. In constructing the caliper the holes through the beam are drilled as accurately as possible, one inch apart, and centered in the longitudinal groove, but are made larger than the holes in the blocks so as to provide for slight adjustment.

* * *

The Cement Age tells of a novel use of cement, it being no less than repairing a hole in the hull of a British steamer. Recently at Newport News, the steamer *Alburea* went into dry dock for repairs, and it was discovered that a large hole through her bow, received through contact with a sharp pointed rock in the Straits of Magellan, had been temporarily filled with a mass of timber, canvas, ballast rock and Portland cement, and that this temporary filling enabled the vessel, without further damage, to make her port. The cement was so strong that the chief of the hull construction at the dry dock found that it would take some six weeks to chip it out with the ordinary appliances, and finally he was compelled to put in small charges of dynamite, and after three days of blasting the cement was at last removed, without injury to the vessel upon the dry dock.

LETTERS UPON PRACTICAL SUBJECTS

MODERN WORK WITH ANCIENT TOOLS.

Editor MACHINERY:

The four accompanying photographs, which, I trust, will be of interest to the readers of MACHINERY, show a high-pressure steamboat engine cylinder built at a shop in which the writer worked some time ago. The engines being built were compound, and cylinder sizes are as follows: Two low-pressure cylinders, 63 inches bore by 144 inches stroke; length over all, 13 feet 6 inches; weight, 48,000 pounds. The above cylinders were not cast or machined in the shop that had the contract as they could not handle them, though they were assembled there, being handled by jackscrews, etc., and carried down the streets of the city, on planks and rollers a distance of ten blocks, by a house-moving apparatus and horse power. The high-pressure cylinders were 28 inches by 144 inches by 136 inches over all; weight, 24,000 pounds; and designed for 200 pounds pressure.

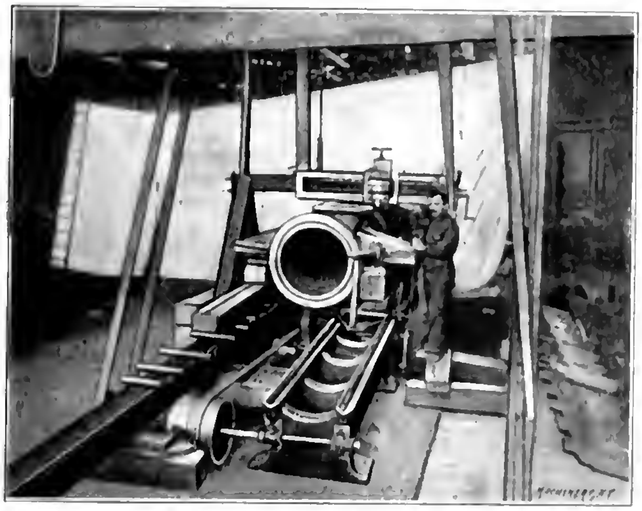


Fig. 1. A Small Planer Widened to take in a Large Cylinder

Fig. 1 shows an end view of the cylinder, which measures 64 inches across to ends of supporting lugs shown. The object sought was to plane the seats for the steam chests (shown at top of photo between lugs) a surface of about 26 inches by 14 inches. The planer was an old New Haven, which had been in use forty-two years, and could be heard two blocks when running. It was 40x40 inches and was widened out about 30 inches for the job at hand. The housing was taken out on the outboard side and moved over on the stone foundation, holes

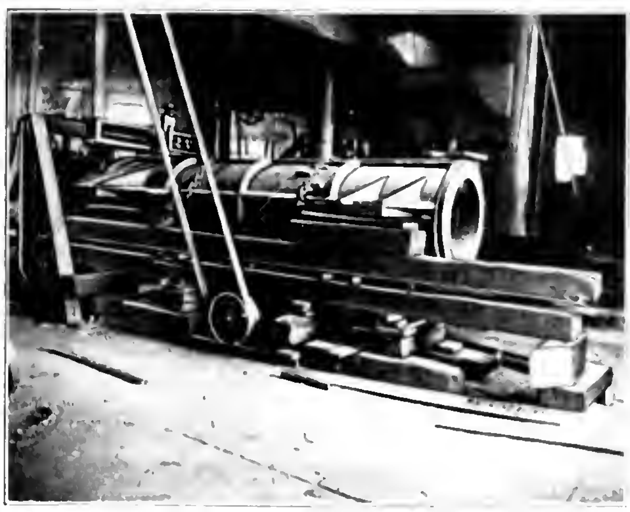


Fig. 2. Method of Supporting Overhang of Cylinder

drilled in the rock and bolted there. The crossrail was lengthened with a 10-inch I beam and shored up with 8x8 inch timbers as shown in Figs. 1 and 3. An extra countershaft was put on the floor in front of the planer bed, and a belt was run in a horizontal position under the blocking shown. Timbers, 12x12 inches, were blocked up on the off side of the planer, for a runway to support the overhung part of cylinder. Some pipe was trued up to a uniform [illegible] for rollers

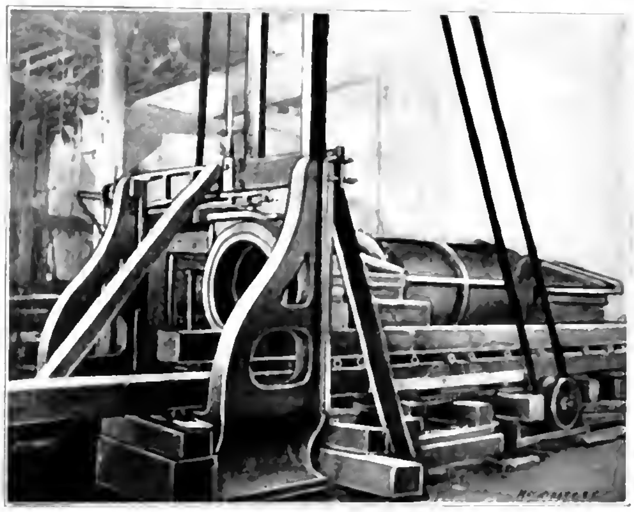


Fig. 3. Bracing for Extended Crossrail.

and another 12x12 inch timber was bolted to the cylinder as a shoe to roll along with the travel of the planer bed. The original driving pulley is shown in Fig. 1, just beside the gear and pinion and under the forward end of cylinder. The countershaft was in part bolted to the end of the planer bed.

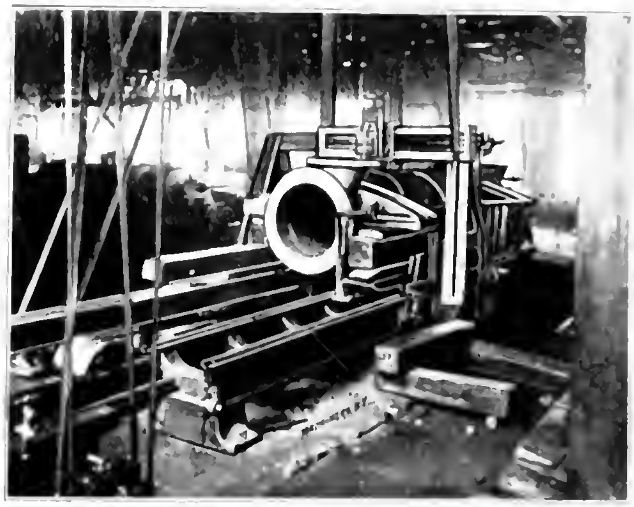


Fig. 4. Blocking, Clamps, etc., for Holding Work on Platen.

As there was no crane available to handle a piece this size it was put on and off the planer by jackscrews, crowbars and a good supply of cuss-words. The shaft for these engines weighed 10 tons and was of nickel steel, 47 feet long and hollow. This shop has since gone out of business; died after this job.

ERNEST I. P[illegible]

Dubuque, Ia.

BLANKING AND FORMING DIES.

Editor MACHINERY:

I send two sketches of a class of dies that has helped me out of more than one tight place. In these dies of the "follow" or "gang" type the blank is partly outlined, pierced and formed before it is finally dropped through the blanking die proper.

The first three figures show the punch and two views of the die which produces the blank Fig. 4. The punch needs no description, as the sketch is sufficiently clear. In Fig. 2 we have a sectional view of the die on a line through the center of hole *b* and ears *d d*. In cavities *a* and *b* there are spring plungers. These plungers form a solid bottom for forming portions of blank marked *a* and *b*. The die *B*, of tool steel, is

made as usual, and then the cavities a and b are recessed from the back and the plungers fitted so that normally their tops are flush with the top of die. Enough play is left in the recess underneath them so that they will bottom solidly on the cast-iron bolster A when portions a and b of the blank are properly formed. The length of the punches is regulated, of course, to meet these conditions. Springs in bolster A force these plungers up flush with the face of the die as soon as the pressure of the punch is released; they should be made heavy enough to act as strippers.

On introducing a strip of stock at the right side of die almost to cavity b and tripping the press, we pierce the two rivet holes shown in blank; also blank and form portion a, Fig. 4. The punch, of course, is relieved at the bend the full thickness of the stock. Moving to next position, cavity c forms a stop by ear a dropping into it. Then, on tripping the press, portion b is depressed and the punch, being relieved at d d and e as before, cuts through the metal around b with the exception of the relieved portions merely bending those parts. The next operation cuts out d d and e and drops the blank through the dies pierced, formed and blanked out.

The punch and die shown in Figs. 5 and 6 is for making the pawl shown in Fig. 7. This die also pierces, forms and blanks the piece.

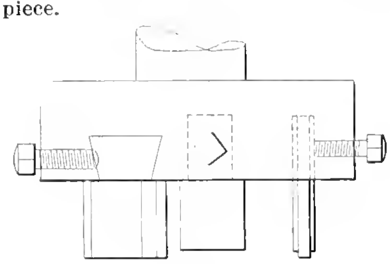


Fig. 1

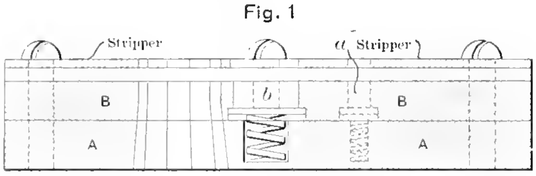


Fig. 2

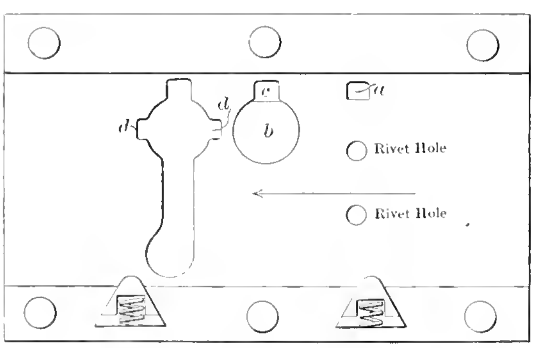


Fig. 3

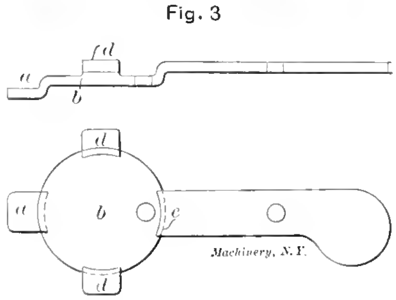


Fig. 4

Blanking and Forming Die, with Example of Work.

The first location, at the right, consists of the piercing die f which blanks out the point of the pawl g by piercing the stock immediately adjacent, as at i. For the next location, we place the hole f on the locating stud, and form the point of the pawl at h. The punch for this operation is longer than the rest and is rounded nicely on forming side, as shown. The next operation blanks out the pawl and drops it through the die. This die should be a trifle longer than the blank on the point so that the punch can be entered into the die at this point before cutting commences. The punch is ground as shown for this express purpose. I used a "plate" stripper on die with good results.

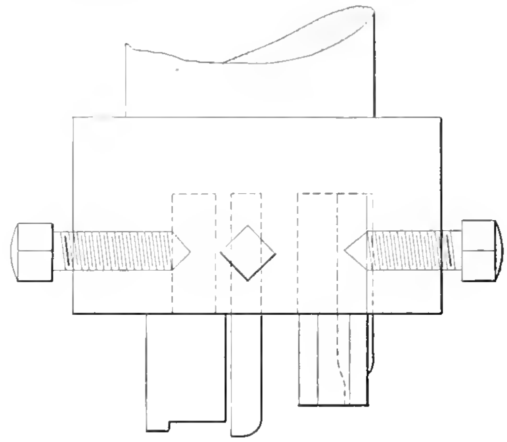


Fig. 5

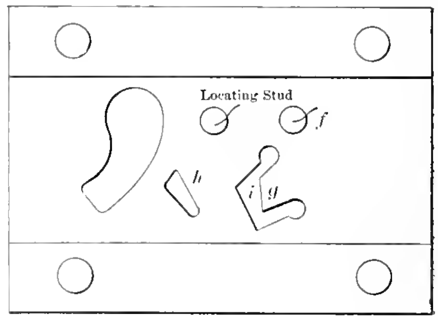


Fig. 6

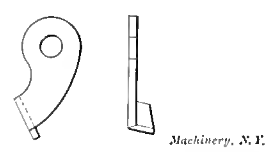


Fig. 7

Pawl and the Punch and Die used in its Manufacture.

Our work is mostly shuttles, of which we make nearly forty varieties. We now put but two operations on an average on each shuttle spring, *i e.*, blanking and forming.

Belvidere, Ill. V. H. MARCELLUS.

APPLIANCES FOR BORING, FACING AND TURNING SMALL SPUR GEARS.

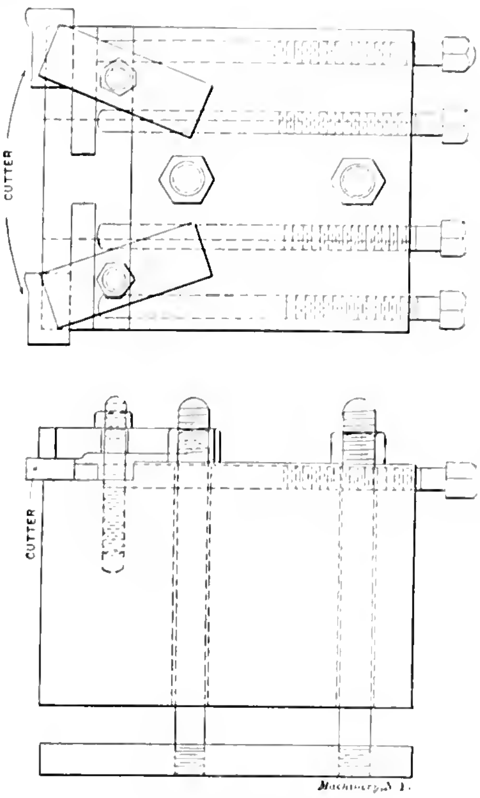
Editor MACHINERY:

Herewith are described the fixtures and methods of using the same for the rapid and accurate boring, facing and turning of spur gears of any diameter from 2 inches up to 10 or 12 inches, according to the needs of the maker. This method applies to all gears, whether solid and with a key-way; solid and without the key-way; with a web and with or without a key-way; it also applies to gears with spokes, with key-way, or without key-way. There are many manufacturers who make a large number of spur gears of the same size or rather who make a number of different sizes and a large number of each size. To those who do make a large number of spur gears of the same size, this article should be especially interesting.

We will suppose that a manufacturer is a maker of engine lathes. Of course all engine lathes are supplied with a set of change gears. To commence with the operations, begin with either the largest or smallest gear and work either from the largest to smallest or *vice versa* so to have the gears follow along according to size.

The first operation is to bore to size and face one side; this is done in an ordinary lathe chuck. For boring the gear, use a centering tool to make a hole to start the drill in; then drill the hole with a drill which is 1-64 inch smaller than the desired size; then face off the side with the tool shown in the cut.

After facing off the side, the reamer is used to get the hole to the desired size. After the whole lot of gears are bored and faced on one side the next operation is to face off the remaining side. To do this use a taper plug made to fit the spindle of the lathe with the part that projects from the spindle shorter in length 1-16 inch or more than the width of the gear when finished, and turned to fit the gear. With small gears which have a key-way, a key inserted in the plug is sufficient to drive the gear in facing the remaining side. With larger gears which have a web or spokes, a driver is used on



Tool Block for Facing Small Gears.

the faceplate. A ½-inch to ⅝-inch pin made to drive in a hole in the faceplate and to bear against a spoke or a lug cast on the web is sufficient to drive the larger gears. Where there is no key-way used in the gears a hole will have to be drilled in the side of the small solid gears for the driving pin to enter to drive the gear.

For turning the outside diameter of the gears use a gang arbor capable of holding from 6 to 12 gears when faced on both sides. An ordinary nut on the end of the gang arbor will hold gears in good shape for turning even as large in diameter as 8 to 10 inches.

The toolholder shown in the cut is to be fastened on the cross slide of lathe by the two studs and strap at the bottom. The cutters are separate, and are backed by a loose gib. The screws come against the gib for adjusting the cutter. Each cutter has a separate clamp and stud for clamping down. The cutters can be moved relatively to each other as the diameter of the gear varies. The front cutter faces the hub while the rear cutter is facing the rim. For small solid gears the front cutter alone is used.

C. J. SHAW.

BORING TAPER HOLES IN LATHE TAIL SPINDLES.

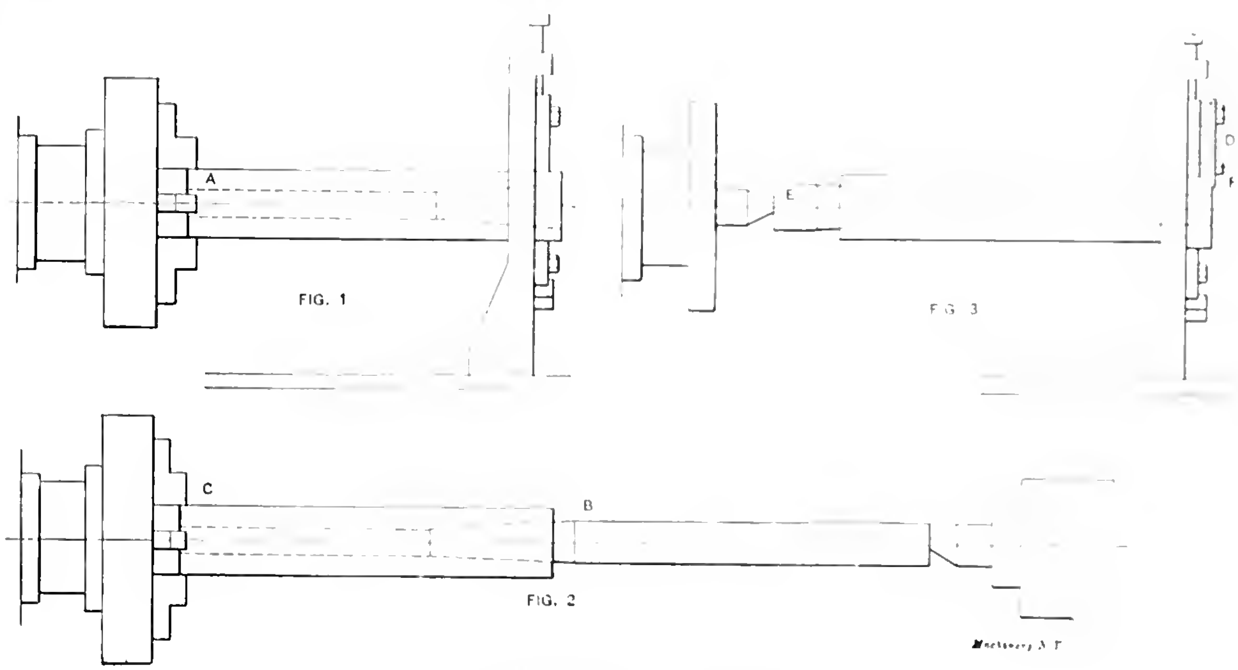
Editor MACHINERY:

The alignment of the taper hole in the tail spindle of a lathe is not as apt to be closely inspected by users as that of the head spindle, but in some cases it is very convenient to have it true. Any error is especially noticeable when using boring bars held in the tail spindle whether running in a bushing in the hollow head spindle or through a bushing in a stationary rest. For work between centers the hole may point off at quite an angle horizontally without bothering, if it is out vertically it is not noticeable unless it is quite a little out. The writer has found the following method of boring these spindles both inexpensive and accurate:

After roughing out the stock, which we take ⅛-inch larger than the finished spindle, and boring a hole clear through the size of the small end of the center hole, we are ready for our first operation, which is indicated in Fig. 1. We hold one end in a chuck, preferably a good four-jaw independent chuck for convenience in future operations. The other end runs in the center-rest. We run in a couple of chucking drills and then a roughing reamer following up with a few turns of the finishing reamer. A floating holder for the reamer is the correct thing for this job, but if your shop does not afford this luxury a ⅜-inch nut put between the tail-center and the end of the reamer answers all purposes.

For the second operation, put in the arbor as shown in Fig. 2. Make this arbor project about a foot for small spindles and equal to the length of the spindle for larger ones. This will give a convenient length to use and the arbor will not be limber. Now shift the end in the chuck till the arbor runs true at *B*. A very few minutes will bring it true to a quarter thousandth. When it is set, turn a spot at *C*, wide enough for the center rest jaws.

For the third operation turn the spindle around as in Fig. 3. Replace the long arbor with the short taper plug *E*. Both plug and arbor must be accurately ground as the desired results depend on their accuracy. Notice the piece of spring steel at *D* on one of the center rest jaws to hold the spindle



Boring Taper Holes in Lathe Tail Spindles.

back against the live center. This can be made heavy enough to hold a 36-inch lathe spindle and is a very easy way to rig up and is cheap. The adjustment shown is enough for most places and is a great convenience. Now go ahead and bore out the seat for the tail nut, finishing with a boring tool in the tool-post. Then put in a plug arbor in this end and finish fitting the spindle to the tail stock, on centers as usual. The results all depend on careful workmanship, but it takes no special skill to produce good results. This method would not be a good one for head spindles, as they are too long to handle in this way. An arbor long enough to indicate true running of the hole would be too limber.

In case the nut is tapped out of the solid stock, which seems to the writer to be a doubtful process, the same methods would be followed except that the first hole would not be drilled clear through, and the last operation would be the boring and tapping of the nut itself. It would probably also be well to finish turning the spindle on a larger center running on an inside chamfer of the nut instead of on an arbor.

Worcester, Mass. E. H. FISH.

SPECIAL COUNTERBORE.

W. C. Force

Editor MACHINERY:

This counterbore was made to use in a drill-press and proved indispensable for this particular job. By placing cutter No. 2 in the bar, which is held in position by the tongue, groove and taper wedge, surface D was faced. By placing cutter No. 1 in the bar, hole D_1 was counterbored. In using this counterbore the drill-press was employed as in ordinary counterboring. To counterbore the under surface D_2, the drill-press spindle should run in the same direction, but instead of feeding the spindle up (which would pull the counterbore out

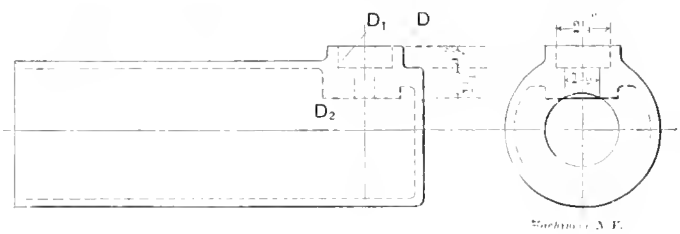


Fig. 1. The Casting to be Machined.

of the spindle), it is fed with the nut A on the shank of the counterbore. By making the cutter No. 1 cut the surfaces D and D_1, it takes one operation less to do the job. In order to

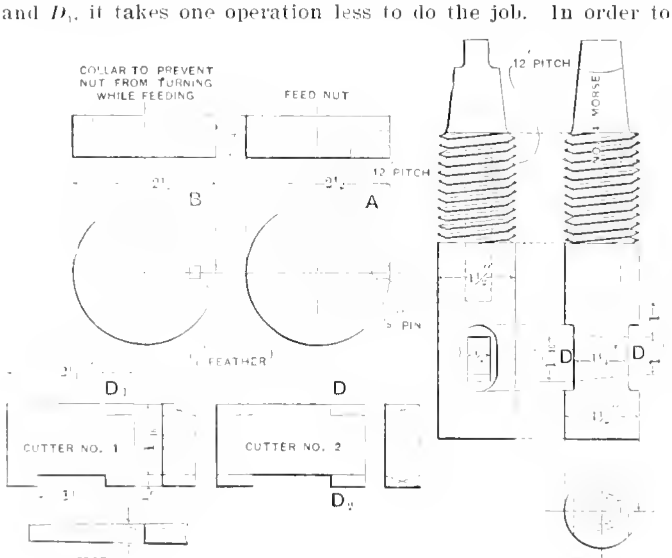


Fig. 2. Details of Counterbore.

get the cutter No. 2 in place it is necessary to run the shank of the counterbore down through the hole in the cylinder and place the cutter into the bar through the hole in the end of the cylinder.

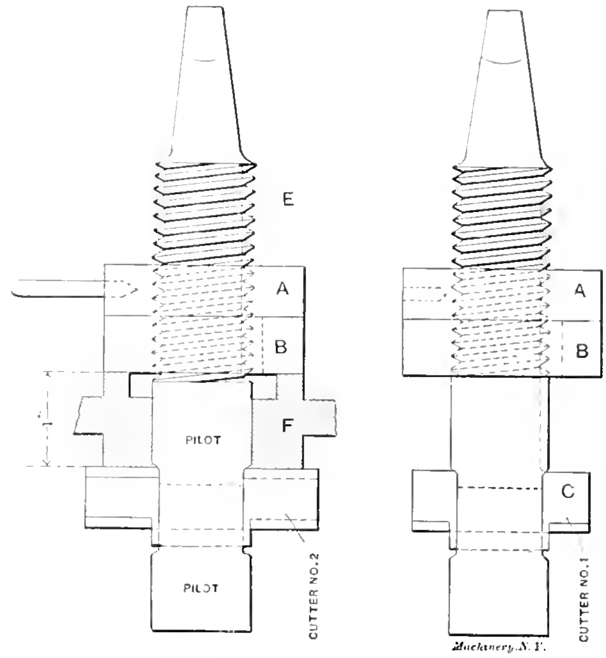


Fig. 3. Assembly of Counterbore.

By having the keyway E in the shank of the counterbore squared up at the end and the right distance from the cutter to equal the dimensions of the work, it is possible by feeding on the nut until it strikes the end of the slot, to get the right thickness at F without any measuring.

Plainfield, N. J. W. C. FORCE.

AN ELECTRICAL REPAIR JOB.

Editor MACHINERY:

This particular armature had already done lots of good work in its time and electrically speaking was in good condition. It was of the engine type, that is to say, it allowed its shaft being withdrawn without in any way interfering with the relative position of the commutator to the winding. Originally the keys had been of a badly fitting character and the spider itself must have been a bare sliding fit on the shaft instead of a press fit as is usual in such cases. As a result the armature had gradually worked loose on its shaft, which had become slightly grooved. It was decided to re-bore the spider and make a new shaft and the order was given that it was to be a shrink fit. This at first sounded rather alarming for we felt rather dubious over the shrinking part of the job. but the matter was gone into seriously and it was decided that we could make a job of it.

The first operation was to fix up the job on the table of the horizontal boring machine, and this had to be done nicely so as to allow of its being truly bored. It was set from the commutator face which had been newly turned up and from certain machine marks at the rear end of the spider. After boring, the keyways were cut which was done by sliding the bar with a cutter and opening up the old keyways to respectable dimensions. This was a very tedious job and did not allow of any taper for top fit. The spider was 18 inches internal diameter by 35 inches deep. It was chambered out 15 inches, thus leaving two sleeves 10 inches long at each end for fitting. The shaft was turned dead to standard gage with a slight lead at the nose for insertion into the hub. This shaft also had a flange against which the spider hub fitted when in place and it was necessary that it should fit tight against the face in order to allow the insertion of several bolts which played a part in the scheme. An allowance of 0.005 inch was made for shrinkage and a pin gage was made a full 1/32 inch large to gage the expansion of the hub when hot.

The armature was set up over a pit so that the shaft could be stepped vertically. By means of a cylindrical coil spirally constructed and furnished with gas and air blast the hub was made hot. The winding was carefully insulated from heat in-

WILLIAM C. FORCE was born at Plainfield, N. J., 1872. He served an apprenticeship with the Walter Scott & Co. Press Works, and is at present foreman toolmaker with the concern with which he served his time; his specialty is jigs and tools, milling fixtures and designing.

fluence by means of asbestos and in due time the eye had expanded sufficiently to allow the insertion of the pin gage. In no hurry, the hub was allowed to soak a little longer while attention was paid to the shaft which was suspended vertically from the crane ready to be lowered at the proper moment. This ready, the burner was withdrawn, the shaft left in up to the flange and arrangements immediately made for cooling off. Now the point to cool off first was undoubtedly that near the flange, for if the opposite end seized and contraction set in, then a space would be left at the flange end and an unsatisfactory job be the result. So particular attention was paid to that part, and under the influence of a judicious supply of water the job was properly cooled off and placed in the lathe for testing. We found the commutator was just 1/64 inch out of truth. JAYMAC.

CONSTRUCTION OF AN OLD COFFEE MILL.

Editor MACHINERY:

One can't put this in as something new as it is old enough to vote at least seventy-five times.* I send you this to show how little if any improvement has been made in the manufacture of coffee mills. This was bought in Germany about 1820 and had been on the market then for some time. The top *A*, body *B*, and bottom or receiver for the ground coffee *C*, are of wood in the shape of a barrel, and nicely finished. It is about 3 inches in diameter and 6 inches high. As I understand it, when a person traveled in those days, he filled the body of the mill, and when he got to an inn, procured hot water and made his coffee. As this mill is small and holds only a little coffee, they must have made very weak coffee or else the coffee bean of those days was much stronger than that we have.

Fig. 1. An Eighty-five Year Old Coffee Mill.

If you will go home and pull the coffee mill apart, you will see that the "insides" are just like this. This one seems to be made of wrought iron. Note the folding handle how it is turned down at *D* to form a stop and at *E* it is simply bent up and the wooden handle pushed over and riveted on.

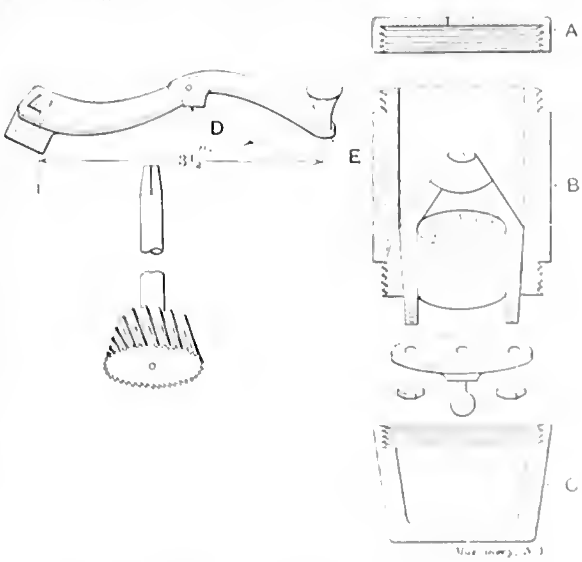


Fig. 2. Details of Construction of Coffee Mill.

New York. HERMAN JONSON.

*From this we infer that a coffee mill can vote when ten years old.—EDITOR.

MILLING CUTTERS WITH TEETH CAST IN.

Editor MACHINERY:

Noticing several articles in the last few issues of MACHINERY, relative to the securing of inserted blades in milling cutters, leads me to suggest the following simple and inexpensive method which we have found very successful in our shop by actual experience.

We make a plain disk pattern of required size for the cutter head and attach to it core prints of the proper size and position for the cutters. Then the cutters, which are of self hardening steel, are placed in the prints in the mold, just as a core would be placed. The cutters are dipped in oil before inserting in the mold as this removes all dirt and makes the cast iron adhere closely to the steel when they come together. The casting is taken from the sand as quickly as possible after pouring, to cool off in the air. We find that the casting shrinks around the steel cutters, holding them very firmly. Notches are made in the cutters to insure against their loosening.

Milling Cutter with Teeth Cast in Place

This process softens the self hardening steel cutters to some extent, but there is no difficulty in heating them at the forge in the ordinary way and cooling in an air-blast to get the required hardness. After this the cutting head is machined to fit the arbor and the cutters are ground to the desired shape. This is the simplest and most inexpensive method of making inserted blade mills that has come to my observation.

Such mills can be made with the cutters set in from the edge of the head so as to be surrounded by metal on end mills or the sides of the cutters can project beyond the head sufficiently for use as a facing mill. W. L. FAY.

Dexter, Me.

DON'T USE LARD OIL ON MACHINERY

Editor MACHINERY:

Apropos to the list of "Don'ts" as published in the June issue of MACHINERY, I would beg leave to add one more, and that is: "Don't oil up your machine with lard oil." I have seen this done so often by journeymen as well as apprentices that I have almost come to the conclusion that it is an incurable evil.

A mechanic who has any pride in his ability at all will not oil up his machine with anything else but machine oil. It is, however, the careless, hurry-up journeyman who uses lard oil; just because the machine oil can does not happen to be handy and the "Old Man" is in a hurry for the job.

I once asked an apprentice whom I found oiling up his lathe with lard oil, why he did not use machine oil? He replied that somebody had "swiped" his machine oil can, and that lard oil was just as good, and besides he could squirt it in a good deal easier.

For the benefit of any other apprentice who may be in the dark in regard to the difference between lard oil and machine oil as a lubricant I would say that lard oil should never be used in oiling up a machine of any kind, not even a lawn mower; for not only does it gum up the bearings but its lubricating qualities are few and far between.

It may not be amiss to add in conclusion that every oil can should be marked in some manner denoting the kind of oil it contains. It is much cheaper to do this than to have the workman squirt some of the contents of the can on a bench block or on the floor in order to find out what kind of oil it is.

C. F. EMERSON.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

AN ADDITION TO THE B. & S. MICROMETER DEPTH GAGE

In die sinking a depth gage is an important tool. The B. & S. depth micrometer is all right for flat work but on curved work it is rather awkward. It does not give the exact depth and prevents one from seeing the point of the rod; Fig. 3 illustrates this. Figs. 1 and 2 show a simple addition which overcomes the objections and increases the tool's

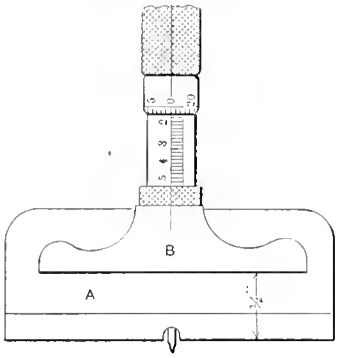


FIG. 1

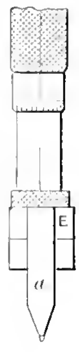


FIG. 2

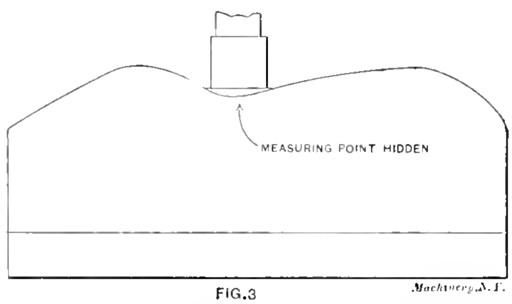
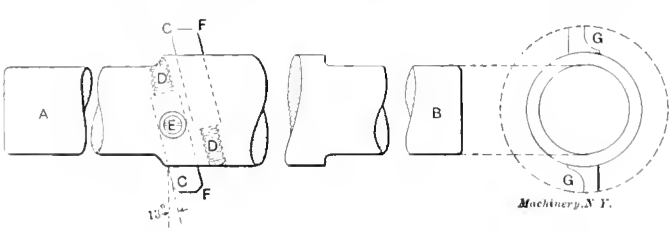


FIG. 3

usefulness, especially when used on spoon and fork dies. *A* is a piece of tool steel about 5-32 inch thick, fitting snugly over the micrometer depth gage. The ½-inch dimension enables one to slip the rod down to the ½-inch groove, and read the depth direct. C. W. SHELLY.

A FINISHING BORING BAR FOR BRONZE.

The cut shows a boring bar designed for taking a finishing cut on bronze castings in a turret lathe. The end, *A*, slides in a bushing in the hollow spindle of the lathe and the end, *B*, is clamped in the turret head. The angle at which the cutters are placed (on this size bar, 13 degrees) is necessarily different for every size bar, so as to keep the leading edges of the two cutters, *C*, even. The cutters are made from ½-inch round stock. They are backed up and adjusted by the screws, *D*, and fastened securely by the setscrews, *E*, which seat on



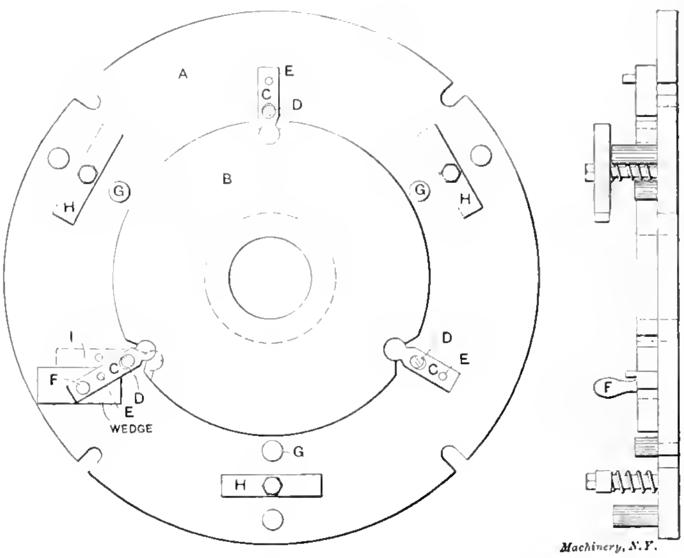
a flattened spot on the cutters. In making the cutters they are fastened in the bar, the bar put on centers in a lathe, the cutters turned to size and the leading edges, *C*, faced off, as shown. The back edges, *F*, are also faced off to give each cutter the same width of face. The top side of the front and the bottom side of the back cutter is then cut out, as shown at *G*, and the ends and leading edges, *C*, are backed off with a file. They are then ready to be removed from the bar for hardening and tempering. If it is desired to use self-hardening steel for cutters they can easily be ground between centers instead of being turned. M. H. BALL.

Watervliet, N. Y.

CHUCKING FIXTURE.

The cut shows a chucking fixture for a Brown & Sharpe vertical chucking machine. This fixture might be used for chucking pulleys, gears, or any other circular work that might suggest itself.

It consists of a cast-iron plate *A* which bolts to the table of the machine. Into this plate is fitted another cast-iron plate *B* having three holes drilled and milled out to receive the levers *C*. These levers are pivoted at *D* and have a pin *E* in

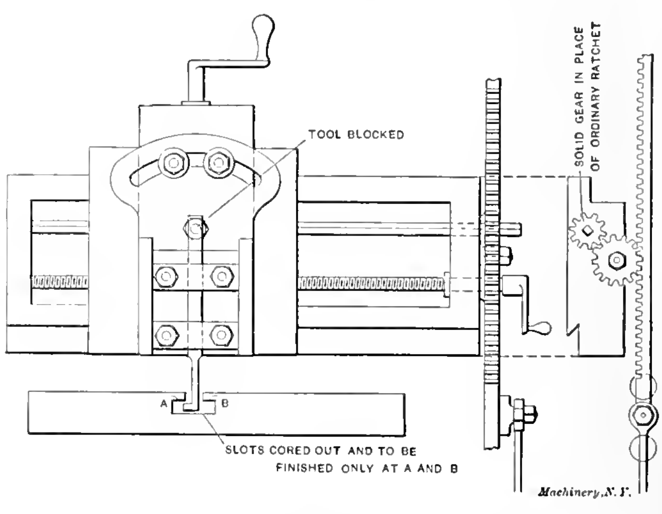


the end. One of the levers has a handle *F*, which is used to operate them. By moving this lever it causes the plate *B* to rotate, thus moving the other levers until they come in contact with the work. As they all move the same amount, it is obvious that the work will be central with the fixture. The work rests on pins *G* and is held down by straps *H*. The dotted lines at *I* show the position of the lever when in contact with the work. Also a wedge is shown between the lever and a pin to lock it in position. P. A. R.

FEED RELIEF FOR PLANER UNDER-CUTTING TOOL.

Of course it is true that there is nothing new under the sun, but as you say in your June editorial, the old things that have been tried and proved are what we young fellows need.

I hit upon a plan to relieve an under-cutting tool on a planer when on the return stroke, which may interest some of your readers. I had a number of T-slots to cut, which were closed



at one end, so could not lift tool out on return. I blocked the hook tool solid, and put a solid gear on feed rod in place of usual ratchet. In this way you will see that the head would move up and down at every stroke. I then adjusted the feed so it would move the tool down at the end of cut and up again when back out of the way. H. D. ELLIOTT.

Oil City, Pa.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

RUST JOINT.

Mix 10 parts of iron filings, 3 parts chloride of lime with enough water to make a paste. Apply this mixture to the joint, bolt firmly together and in twelve hours it will be set so that the iron will break sooner than the cement.

Detroit, Mich. DAVID MELVILLE.

TO MAKE BLACK MARKS ON GRADUATED SURFACES.

The scale is varnished over with a little thin shellac varnish, so as to sink into all the cuts. When this is dry, a black varnish of lampblack and shellac is spread on, so as to fill all the cuts. This is allowed to *thoroughly dry*. When hard, the work is driven in the lathe, and the superfluous varnish polished off with fine flour emery cloth until only that in the cuts is left. This gives a very distinct marking and fine finish to scale.

Angelica, N. Y. F. H. JACKSON.

CEMENT FOR METALS.

A very good cement that I have used for cementing metal parts consists of the following ingredients: 2½ parts zinc oxide; 1 part zinc chloride; 5 parts pulverized limestone, slag, etc. Mix to a thick paste using water. If the cement is wanted to set slowly add 1 part of zinc sulphate instead of one part of zinc chloride. The adhesive power of this cement can be increased by adding 2 per cent of ferrous sulphate to the whole. HERBERT S. GLADFELTER.

Desloge, Mo.

TO BLACKEN BRASSWORK FOR INSTRUMENTS.

To give a dull black surface to brasswork paint it with a mixture made of a thimbleful of lampblack, to which is added 4 or 5 spots of gold size. Mix well with a knife on a flat slate until the whole is about as thick as putty. Only put sufficient gold size to make the lampblack stick together, as too much will make a bright instead of a dull black. Add about twice the volume of turpentine to the mixture, stir well with a camel's-hair brush, and apply to the brasswork.

Rochester, N. Y. JOS. M. STABEL.

COPPER SOLUTION THAT WILL COLOR ON OILY STEEL.

To make a copper solution that will color on oily steel, take ½ ounce sulphate copper (blue vitriol), 4 ounces water, 1 tablespoonful oil of vitriol (commercial sulphuric acid) and dissolve the sulphate of copper in the water, then slowly add the oil of vitriol a few drops at a time, shaking well at each addition. Keep the mixture away from the face when adding the oil of vitriol; if the oil of vitriol is all poured in the bottle at once the stuff will boil and shatter the bottle, as I learned by experience. A friend of mine has a scar from an acid burn in his eye from same cause. F. W. B.

ACID HARDENING BATH.

To make an excellent hardening solution, mix pure rainwater and salt strong enough to float a raw potato, and to twenty gallons of the brine add three pints of oil of vitriol. Tool steel may be hardened at a surprisingly low heat in this solution, a very great advantage, of course, when hardening difficult shapes. The solution, however, has one slight disadvantage in that it causes the steel to rust quickly unless the steel is thoroughly scrubbed in strong hot soda water immediately after hardening. Tools hardened in this solution should come out of the bath a beautiful silver gray color, and if there are any black spots they are likely to be soft.

I. W. ANTANO.

MORTAR FOR STOPPING HOLES IN BOILER SETTINGS, ETC.

I have successfully used the following simple mortar for stopping leaks in chimneys, etc.; it is good for stopping cracks in boiler settings and other brickwork structures where not exposed to very high temperatures. Although of an improvised and primitive nature it answers the purpose very well, and has the merit of being made of materials available almost everywhere. Mix hardwood ashes, 3 quarts; chimney soot, 1 quart; common salt, 1 quart; and sufficient water to make a stiff mortar. Apply at once as it hardens quickly. This is a very old receipt; in various proportions it was used by our forefathers years ago. F. EMERSON.

Newark, N. J.

COLD TINNING PROCESS FOR USE ON FINISHED WORK IN IRON, BRASS OR STEEL.

To tin by cold process finished work in iron, brass, or steel such as pins, tacks, wire goods, etc., put twenty pounds of stock well cleaned in sawdust, in a deep pan (14 x 20 x 3 inches is a good size) having a false bottom of zinc. Heat to the boiling point a mixture of ¼ ounce of sulphuric acid and 2 ounces of tin crystals (stannous chloride) and pour over the work. Let it stand ten minutes and then stir well, using a rake, and then let it remain ten minutes longer. Repeat the process and if two coats are not enough, give it a third coat. The zinc bottom must be washed twice a day, as rusty or oily work will not tin satisfactorily.

To polish the work, put in a wooden tumbling barrel and pour in a water pail full of strong soap and water. Let it tumble fifteen or twenty minutes, according to the nature of the work, and then tumble for a few minutes in hot sawdust to dry it. J. L. LUCAS.

Bridgeport, Conn.

AMALGAM FOR STOPPING LEAKS, BLOWHOLES, ETC.

A small hole or crack that is difficult to get at or that cannot well be soldered may be closed with an amalgam composed of zinc 66 parts, tin 44 parts, and sufficient mercury to make a stiff dough. The zinc and tin are to be melted together and afterward granulated. The latter may be done by slowly pouring the melted mixture through a strong stream of water from a hose nozzle; or the filings may be used. The filings or granules are kneaded until an amalgam of the consistency of stiff dough is formed with the mercury. Excess of mercury should be squeezed out. The plastic mass is then forced into the opening and allowed to harden for an hour or two. It can then be filed and scraped like the metal itself. Only as much amalgam should be mixed as is required for immediate use.

Chicago, Ill. O. M. BECKER.

TO PRODUCE A MAT SURFACE ON STEEL.

To make a non-reflecting or mat surface on small steel articles such as screws, small steel stampings, etc., which at the same time shall be perfectly rust-proof, proceed as follows. Mix 2 ounces of powdered tartar with 20 ounces of water. Put the articles to be treated into this mixture in an earthen pot, and boil until they become yellow. Then place the articles in a tray with a solution of sulphate of copper (blue vitriol); take out when copperized and put in a tray with sulphur ammoniac. When black, take out and rinse off with water. After the rinsing has been done carefully, mix a quantity of clean, very dry beechwood sawdust with sufficient sweet oil, to render it slightly oily. Then thoroughly mix and rub in some powdered graphite, but only enough graphite should be added to give the whole a blackish appearance. Throw into the sawdust the steel parts to be blackened but not more at a time than about 1/3 of the quantity of the mixture. Put the whole in a small coffee-roaster such as is used in private houses, and after shaking well, roast the contents over a gentle flame, in constant motion, until the sawdust is burned to charcoal. The parts are then ready to be taken out and cooled. The roaster should be tightly closed during the roasting operation.

It is not necessary to lacquer the parts as the color put on in this manner will not wear off by ordinary handling. The parts will have a nice mat surface suitable for articles used in photographic manufacture and art goods. The formula used was a secret for many years and was successfully used by the inventor. MAX J. OCHS.

Cleveland, Ohio.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

57. O. G.—I would like to have the following inquiry submitted in the reading columns of MACHINERY: Is there an acid which can be used for etching hardened high-speed steel?

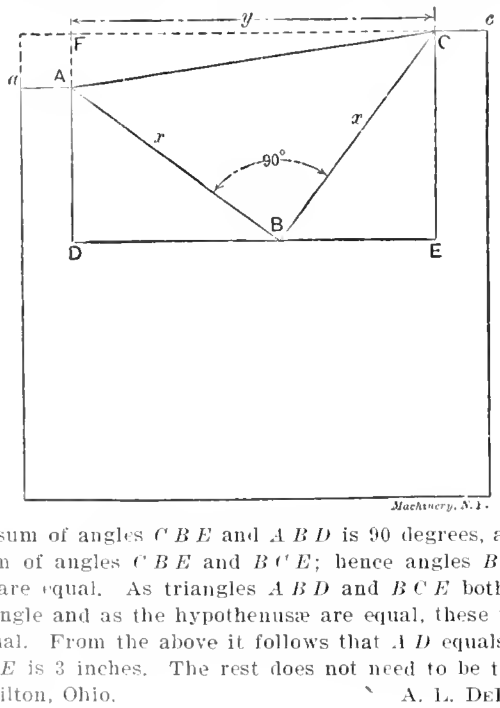
58. J. B. and P. F. L. have sent inquiries regarding the design of friction disk drives. J. B. wishes to use a driving disk 16 inches in diameter and a driven disk 12 inches in diameter, placed at right angles to the face of the driver. The driven disk is to slide on a shaft at right angles to the driving shaft to provide a variation in the ratio of the speed in their direction of rotation; and also so that the greatest power will be had at the lowest speed of the driven shaft. He would like to know the width of face to use for the driven disk when running at 900 revolutions per minute, and also what is the best friction material to employ. P. F. L. wants to know, in addition, the most efficient speed for paper or leather friction disks when running on iron disks.

A. We submit the above inquiries to our readers. Knowing, however, that the Ridgway Machine Tool Co. have recently experimented with friction disk drives for the feed mechanism of their tools, we wrote to their general superintendent, Mr. W. H. Morgan, who replies as follows: "In the writer's experience the best friction material is two leather surfaces running together. It is customary to use one leather surface and one metal surface, but we have found, in the case of our 10-16-foot boring mill, that much more power was transmitted by running two leather surfaces together. It is not practicable to run it near the center of the driving disk on account of the rotary motion obtained there, and the power also being very much less at that point for the same reason. But a comparatively small ratio of speed can be obtained through a friction drive, probably not over 2 to 1. This is due mostly to the circular motion above mentioned. We will also say that the disk which drives by its periphery should be the driver and the flat-faced disk the driven element. For one reason, if the flat disk should be the driver, and the disk that engages with it should become over-loaded and stop, it would immediately be worn flat at that point; whereas if the opposite were the case the leather disk would continue to revolve and wear itself alike all round."

Simple Solution of Question No. 55.

Editor MACHINERY:

Referring to question No. 55, in "How and Why" department, July issue of MACHINERY, I wish to offer you a simpler solution, which, I believe, comes within the scope of anyone who can read the diagram. I will make use of the same diagram that you used, so that a sketch will not be necessary.



The sum of angles CBE and ABD is 90 degrees, and so is the sum of angles CBE and BCE; hence angles BCE and ABD are equal. As triangles ABD and BCE both have a right angle and as the hypothenusæ are equal, these triangles are equal. From the above it follows that AD equals BE, so that BE is 3 inches. The rest does not need to be told.

Hamilton, Ohio. A. L. DELEEUW.

[Similar answers to question No. 55 have also been received from Mr. W. C. Searle, Worcester, Mass., Mr. W. J. Sweetser, Wellesley Hill, Mass., and Mr. E. J. Loring, Somerville, Mass. —EDITOR].

59. J. S. S.—I have made six circular forming tools for screw machine work, three of which are like that shown in the cut, and the other three are very similar. But I have not been able to harden them successfully, as they invariably crack, the cracks starting at the parts marked *A* and *B*. I used Jessop's steel, first using it forged; then cut off the bar,

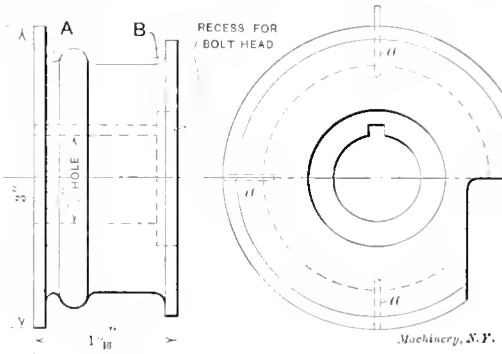


Fig. 1.

non-forged, annealing each piece three times, first, when cut off; second, when turned to within 1-16 inch of finished size; third, when finished, just previous to hardening. In all cases I was careful not to heat above a dark cherry red. Do you think I am using a steel too high in carbon? Would saw cuts as indicated at *a* prevent cracking? Following are the methods of hardening employed:

1. Heated to cherry red; dipped with cutting face up into luke-warm brine. Result: Soft spots and cracks.
2. Dipped into pail of common water with 2 inches of fish oil on surpace. Result: Blue temper and crack developed several hours afterward.
3. Dipped in cold brine. Result: Cracked.
4. Hardened the same as No. 1 and reheated. Result: Cracked in reheating; also cracked when drawing the temper in oil.
5. Hardened the same as No. 2, but did not draw temper. Result: Cracks appeared in about one-half hour.
6. Dipped into lukewarm brine, cutting face up; when cutter stopped sizzling it was plunged into cold fish oil. Result: The temper was excellent, the outside being hard and the hole soft, but it cracked as did all the others.

Answered by Mr. E. R. Markham.

In answering the above, I first wish to state that certain conditions may exist which are unknown alike to the writer and myself; for instance, the steel used may have been taken from a "piped" bar, and the attending imperfection in stock

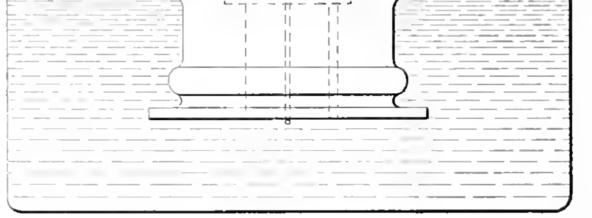


Fig. 2.

may have extended too far from the center to be entirely cut out when the ¾-inch hole was made. This, however, is unlikely, as stock containing a pipe of any size is readily detected. Other conditions which would cause the stock to crack may exist in the fire, or the bath. As it would be useless to speculate on these, we will consider the hardening of a tool of this character under normal conditions. Jessop's steel gives general satisfaction, and probably causes as little trouble as almost any of the steels commonly used. Ordinarily as bought in the open market it contains 1.25 per cent carbon,

which is not too high for forming tools of the character shown. For several years I made forming tools of about the same diameter and thickness of steel containing 1.5 per cent carbon and experienced no trouble from cracking. Annealing after blocking out the blank somewhere near to shape is helpful if properly done, as it removes strains which are set up when the steel is drawn in the mill or forged in, in the blacksmith shop. However, in order to be effective the annealing heat must be as high as the hardening heat, but should be no higher, as high heats are injurious to the steel. It will be necessary to heat a tool having light projections very slowly, as such projections heat much more rapidly than the solid portion of the tool. The piece should be heated to a uniform *low* red; then dipped in a bath of *warm* brine. When I say warm brine I mean brine heated to a temperature of 115 to 125 degrees F. When dipped in the bath it should be placed on a piece of wire bent as shown in Fig. 2 and dipped so it can be worked around in the bath as shown, in order to bring all parts of the cutting surface into contact with the brine, thus forcing steam away from the steel and allowing the liquid to act on the entire surface and preventing soft spots. It is necessary to heat the bath considerably, as otherwise the thin portions of the cutters will harden quickly and become rigid before the balance of the cutter has stopped contracting, hence causing cracks to form. As an additional preventative I would recommend removing the cutter from the brine when it ceases to "sing," and immediately plunge into *warm* oil, working it around in the oil until it is cooled to the temperature of the oil. After it has cooled to this temperature, hold the tool over a fire, turning constantly until it is heated sufficiently to remove "strains."

If the temper needs to be drawn, and it is thought advisable to draw in a kettle of oil, do not have the oil hot when the tool is placed in it or the sudden expansion of the lighter portions will cause them to crack; place in cold or warm oil and gradually raise the temperature to the desired degree, making sure that the oil remains at the proper temperature for some time, in order that the steel may absorb the desired amount of heat, as it will not heat as rapidly as the oil. The three saw cuts indicated at *a* are employed many times to prevent cracking, and work nicely, but take away a considerable portion of the life of the tool and I have not as a rule found them necessary. If used, the cutter employed for making the slots should produce a slot rounding at the bottom, as sharp corners are an invitation for steel to crack when hardened. When a number of cutters of this character are made at a time I have found the method of hardening called "pack hardening" to give the best of satisfaction, as the tendency to crack was entirely eliminated; the cutters were much harder, and yet a great deal tougher than when hardened by any other method. This method has been described in detail in former numbers of MACHINERY.

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60. S. C. T.—We have a frame in which slides a cutter to cut tabs on index cards, such as are used in the modern card index files. The tabs are of varying widths and are located at different points on the upper edge of the card, to suit the wishes of the purchaser. Will you kindly give us a rule for locating that part of the cutter bar which cuts out the tab, the position being such as to enable us to cut the longest possible card for any given width of tab. The card may be turned over so that either side will be up when cutting, as necessary or most convenient. The only requirements are that we may cut the longest possible card and that the tab may be located at any point along the edge of the card. Sketches herewith.

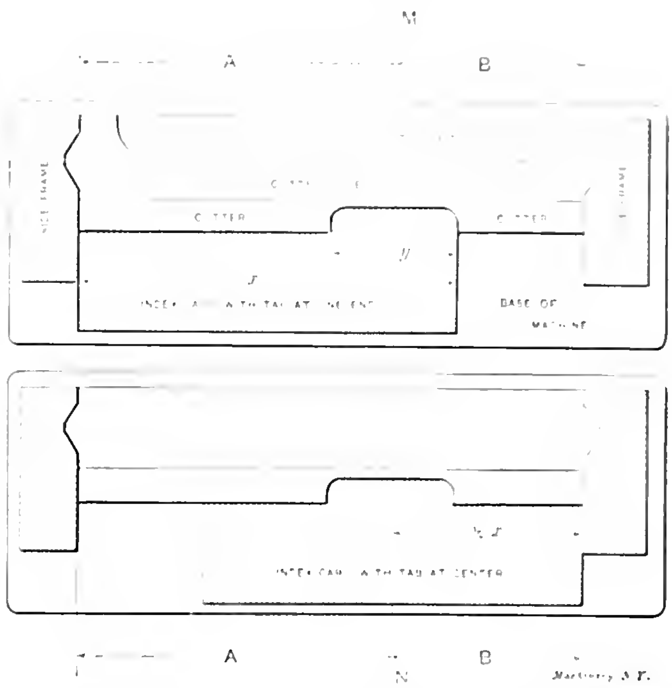
A.—An answer to this question affords a good illustration of a simple application of algebra to a practical problem. We judge that you wish to be able to locate the tab either at the center of the card or the extreme end, or at any point between these two positions. Of the two plan views of the cutting press shown herewith, the upper one illustrates the position of a card when the tab is to be cut at one end and the lower view shows the position of a card of the same size when the tab is to be at the center of the card. It is obvious that if the cutter is so located that the longest possible card can be cut in either of these two positions, any smaller size can be cut, or the long card may be so placed as to bring the tab in any intermediate position. Let $M N$ be the center line of the part of the knife which cuts the tab; $A + B =$ distance between frames; $x =$ length of card and $y =$ length of tab. Then, from the arrangement of the two views of the illustration it will be evident that

$$A = x - \tfrac{1}{2}\,y$$
$$B = \tfrac{1}{2}\,x.$$

Adding, we get $A + B = 1\tfrac{1}{2}\,x - \tfrac{1}{2}\,y$, which gives an expression for the distance between frames in terms of the length of card and width of tab.

Solving for x, we get

$$\tfrac{3}{2}\,x = A + B + \tfrac{1}{2}\,y$$
$$3\,x = 2\,(A + B) + y$$
$$x = \tfrac{2}{3}\,(A + B) + \tfrac{1}{3}\,y$$



Machinery, N.Y.

Assume, for illustration, that the width between frames is 18 inches, and the width of tab to be cut is $1\tfrac{1}{2}$ inches. Then, substituting in the last formula above, $x = \tfrac{2}{3} \times 18 + \tfrac{1}{3} \times \tfrac{3}{2} = 12\tfrac{1}{2}$ inches, for the length of card. The distance B, of the center of the recess in the knife for cutting the tab, from the side of frame, $= \tfrac{1}{2}\,x = 6\tfrac{1}{4}$ inches.

• • •

The distressful boiler explosion which occurred in a shoe factory at Brockton, Mass., March 20, 1905, and caused the death of 58 persons and injuries to 117 more, renews our attention to the danger that is practically inseparable from the lap-joint boiler seam. The boiler which exploded had a double riveted lap-joint longitudinal seam, and a crack developed in such a way that it was hidden by the lap. It is almost impossible to discover such cracks by ordinary means of inspection as they generally start next to the lap and work outward through the sheet. The boiler which exploded was built in 1891 and had been insured by the Hartford Steam Boiler Inspection and Insurance Company during its entire life. It had been carefully inspected only three months prior to the explosion, and so far as the test showed the boiler was in good condition, but the insidious bending action which always is present in a lap joint seam to a greater or less degree had cracked the shell until it had only a fraction of its initial strength. In commenting on this fatal defect of lap-joint boilers, the *Locomotive* says that the thicker the plates and the smaller the diameter of the shells the greater is the liability of this defect developing. Although butt joints are growing in favor among boilermakers and designers it is estimated that at least 85 per cent of all the boilers now in use in the United States still have lap-joints. Hence the great danger of boiler explosions from this hidden defect in the large majority of steam boilers in use to-day. The insurance company have seriously considered the use of X-rays for detecting this hidden defect in boilers but in the present state of the art it is impracticable to use them for inspection work as the size of the apparatus necessary to generate rays strong enough to penetrate boiler plate is too great.

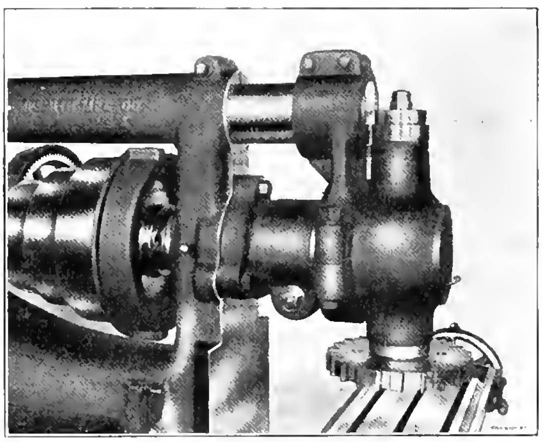
MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

VERTICAL MILLING ATTACHMENT.

In these days of manufacturing milling, the vertical attachment on the horizontal miller plays an important part. The cut shown below illustrates an interesting vertical milling attachment which has been brought out by the Kempsmith Mfg. Co., Milwaukee, Wis. It was designed with the idea of giving sufficient strength and rigidity to handle the same size mills and take the same heavy cuts as the main spindle of the machine. This gives in effect a vertical miller of about the same capacity as the horizontal machine to which the attachment is applied.

The vertical spindle is driven by casehardened steel bevel gears of coarse pitch, and the journals are of sufficient length to give unusually long life to the bearing and to maintain the alignment of the spindle almost indefinitely. Provision is made, however, for adjustment for any wear that may occur. The spindle has a taper hole for end mills, etc., and is threaded to take large facing cutters. Both the taper hole and the threaded nose are the same as on the main spindle, thus making all tools interchangeable. Drawbolts are furnished for drawing in and forcing out endmills, to prevent injury to the shank or teeth when changing tools.



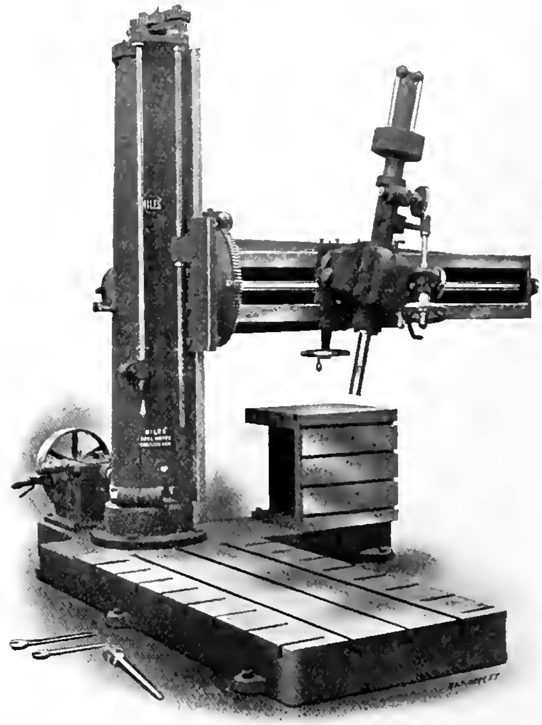
Kempsmith Vertical Milling Attachment.

The head may be swiveled clear around. All angles within the 360 degrees are indicated by graduations, and only the two bolts shown—one vertical, the other horizontal—are required to firmly secure the adjustment. Both these bolts are conveniently located. The design of the head keeps the distance from the center of the horizontal spindle to the nose of the vertical spindle very short, to permit doing work which stands unusually high from the table. The attachment is drilled to the same jig as the column of the machine for which it is intended, so it may be applied to any Kempsmith miller of certain sizes now in use. The device is built in three sizes.

NILES SIX-FOOT UNIVERSAL RADIAL DRILL.

This machine is the result of the experience of its builders with high-speed drills and it has been designed throughout to adapt it to their use. The drill head saddle fits between as well as outside of the arm guides, thus completing the double box section of the arm, insuring rigidity. The column rests on ball bearings, and the post about which it revolves extends to the extreme top of the sleeve. Steel gears, bronze bushings and ring-oiling bearings are used for all fast-running shafts.

A feature of the machine is its ease and convenience of manipulation. All feeds and speeds are changed by means of levers, carefully arranged within easy reach of the operator. Friction clutches are used for starting and stopping the machine at high speeds, reversing gears are provided for tapping, and all changes may be made even when the machine is running at its highest speed.

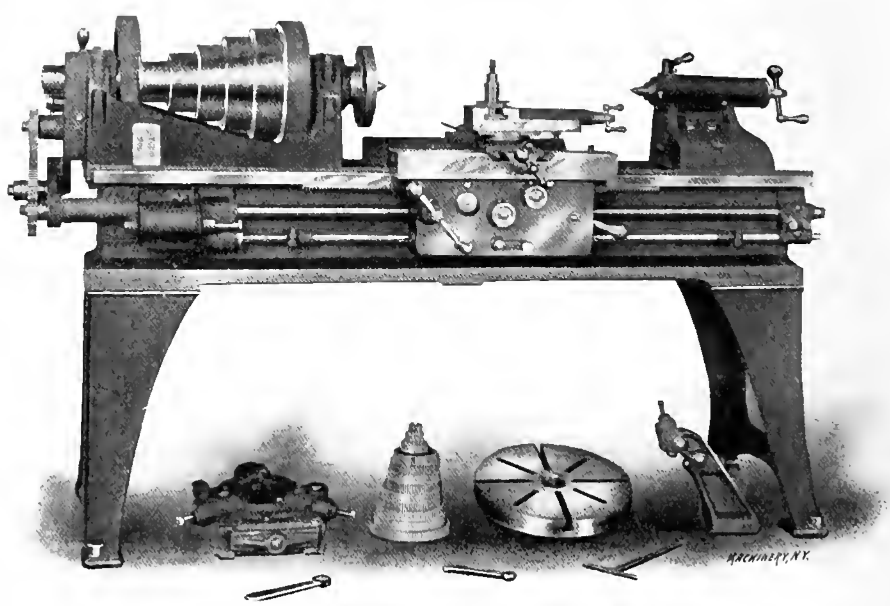


Universal Radial Drill.

This tool will drill to the center of a 12-foot circle, take 72-inch between the end of spindle and base plate, and is a full universal machine, as both the arm and the saddle can be swiveled. It is built by the Niles-Bement-Pond Co., 111 Broadway, New York.

SPRINGFIELD LATHE WITH NEW FEED REVERSE.

The Springfield Machine Tool Co., Springfield, O., are making a lathe somewhat similar in design and appearance to their "Ideal" line but incorporating new features in the feed and thread-cutting mechanism. The feed is reversed in the headstock by the clutch lever shown at the left of the index plate. This mechanism is in addition to the reverse in the



Sixteen-inch Springfield Lathe.

apron, and does away with the intermediate gear with its swinging sector, which usually has to be interposed in the change gear train when cutting a left-hand thread on lathes of this type.

The sliding rod shown on the gear box at the front gives three feeds or threads for each combination of change gears and the small handle at the top increases this number to six. The ratios of the gears in this box are so arranged as to give a suitable range of feeds for turning if the change gears are set for any ordinary thread.

The illustration shows the 16-inch size, but the lathes can be supplied in any size from 14-inch swing up to 24 inch.

QUICK CHANGE GEAR LATHE.

We show below three half-tones which give a good idea of a new feed mechanism which Flather & Co., Nashua, N. H., are putting on their standard line of engine lathes. The large cut shows it applied to the 16-inch size, but they are using it on machines running from 14-inch to to 28-inch swing.

The direction of feed is determined as usual by tumbler gears in the headstock. From here the motion is transmitted by a train of gears, which will be described later, to gear D, which drives shaft A in the feed box. This shaft is cut for a part of its length with teeth to form a long pinion and on this portion slides the lever E. Shaft B carries the cone of gears usual in arrangements of this kind, and pivoted in lever E, but not shown in any of these cuts, is the usual intermediate gear, which meshes with the teeth cut in shaft A, and can be brought into mesh with any of the series of gears on shaft B. Locking pin F locates the lever in each of its different positions by entering into the appropriate hole drilled in the face of the gear box. G is a steel plate fastened to the lower edge of the box, and provided with a notch to match each locking pin hole. A projection on the inside of lever E enters one of these notches, and prevents the lever from being shifted along the shaft until the intermediate gear has been dropped clear of the gears on shaft B.

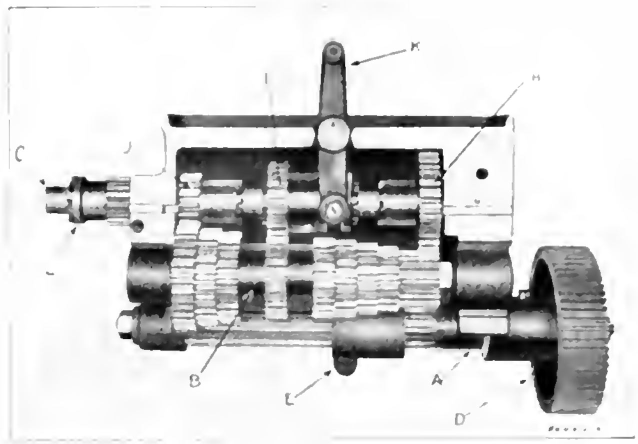


Fig. 3. Interior of Gear Box

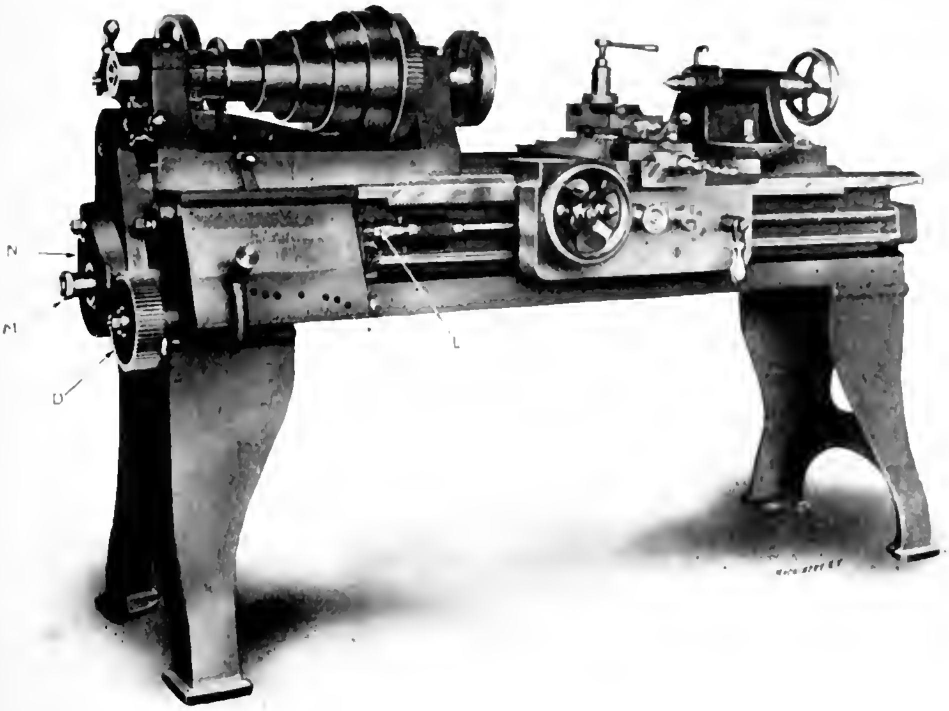


Fig. 1. Flather Lathe with Quick Change Gearing

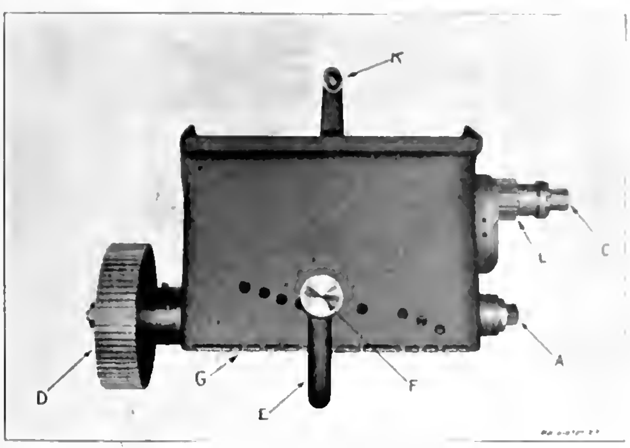


Fig. 2. Front View of Gear Box

A new feature in this device is the fact that means are provided in the gear box for giving three different speeds to the feed rod or lead-screw for each position of lever F. Shaft C has turning loosely upon it two gears, H and J, whose hubs are cut to form clutch teeth. Between these two gears is a third one marked I, which has clutch teeth at both ends of its hub, and is splined to the shaft, but free to move endwise. An endwise movement is given to it through lever K, which projects through the top of the box. When in the position shown the motion is evidently transmitted from shaft B to shaft C through gear I and its mating gear in the series on shaft B. Gear I may be thrown either to the right or left, and thus be disengaged from its mate, but connected by the clutch teeth on its hub with either H or J. As these are run by their corresponding drivers at different rates of speed, each position of the lever E, by shifting lever K, will give three different speeds or twenty-seven in all. This is the usual way of changing the turning feeds in the shop of the manufacturer, lever E being located at a suitable station, the roughing and finishing feeds are obtained by lever K. Gear I has a spring pin in its hub which engages suitable depressions in shaft C, and thus prevents the lever K from being jarred out of place. Shaft C is extended through the gear box and carries a pinion and clutch L, which may be moved to the right to engage the clutch on the leadscrew, or more to the left to mesh with the gear on the feed shaft.

The 27 feeds and threads mentioned are further increased to 54 by means of a sliding gear which meshes with the wide-faced gear D and is moved in or out by the projecting hub seen at M. Suitable gearing in case N alters the ratio of rotation for these two positions. While this arrangement gives 54 feeds varying from 7 to 448 per inch, and threads from 2 to 128, the range is still further extended to permit the cutting of odd threads, metric pitches, etc., since gear D may be removed, and one of any suitable number of teeth inserted in its place.

Some of the novel features claimed for this lathe by the makers are extreme compactness of gear mechanism, strength, simplicity and wide range.

WESTINGHOUSE INDUCTION MOTOR.

A new type of polyphase induction motor has recently been placed on the market by the Westinghouse Electric & Manufacturing Co., Pittsburg, Pa. It is designated as type C C L. These motors are manufactured in sizes from ½ to 75 horse-power and are wound for operation on two- or three-phase circuits, at voltages of 200 and 400 for all sizes except the ½ horse-power. The sizes from ½ to 5 horse-power inclusive

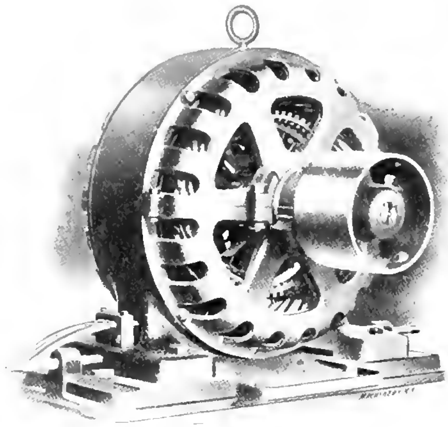


Fig. 1. Westinghouse Induction Motor.

are also wound for 100 volts. The frame of the motor is a solid cast-iron yoke. To the ends of this yoke brackets are bolted in such a way that the motor may be adapted for use on the floor, wall or ceiling. The bearings in these brackets are of ample dimensions and furnished with flooded lubrication by means of oil rings. The wear is exceedingly slight, so no provision for adjustment is made. The stationary part of the motor, which is connected to the source of current, consists of circular laminations of sheet steel securely keyed to the frame. The secondaries of these motors are of the "squirrel-cage" type, a construction which is extremely simple and durable. The winding consists of square copper bars lying in partially-closed slots and secured at the ends by screws to a ring of copper or brass large enough to dissipate the

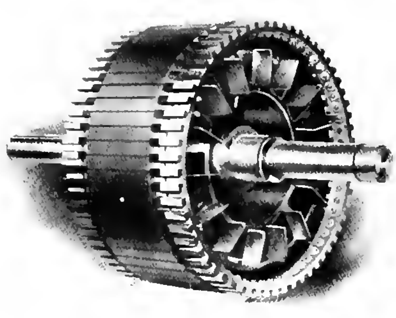


Fig. 2. Squirrel-cage Armature.

heat generated in them. The motor is designed to maintain good efficiency at low loads, so as to insure a high, all-day efficiency. Terminal leads are brought out at the base of the frame, being held in a cast-iron clip. Hand connections or knuckle joints, such as are supplied with railway motors, are used to connect the motor to the supply circuit. The cuts show the 15-horse-power size and the type of armature which is used in this line.

CUTLER-HAMMER RADIAL ARM CRANE CONTROLLER.

The illustrations herewith show a new type of crane controller, known as the radial arm, which is made by the Cutler-Hammer Mfg. Co., Milwaukee, Wis. In designing these controllers the purpose was to attain, with simple construction, proper control with the minimum number of points at which arcing could occur as the controller deteriorated in service, and to make certain that when arcing did occur it would be under pre-determined conditions and with ample protection.

In types *B* and *C* the front is mounted above the resistance, thus giving free accessibility to the connections on the back of the slate. The front itself consists of four sets of segments, the connections of which are so arranged that no reversing sector is necessary. The resistance is also arranged in four sections, each connected to its respective set of segments, making the wiring simple, and eliminating all crowding. The lever is in three pieces, insulated from each other. Before being separated this lever is cast in one piece, and all work on it is done with jigs, to insure interchangeability. The blow-out consists of a coil surrounding and embracing the controller shaft on the front of the controller, and the iron of the frame work is so disposed as to complete the magnetic circuit and give a powerful blow-out action at each of the four points at which the circuit is broken. The provision of a multiple-protected break for the circuit reduces destructive arcing to a minimum. A reliable center

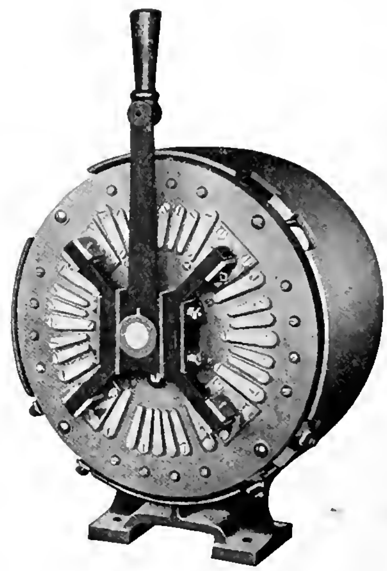


Fig. 1. Cutler-Hammer Crane Controller, Type A.

indicating device is provided, which enables the operator to feel the central or "off" position, but which will in no way prevent his reversing quickly.

The type A controller differs from the above only in the mounting of the resistance, which is of iron inclosed tube porcelain insulated construction, and is carried directly by the front. The type A controller and resistance may therefore be removed from the enclosing case and mounted directly in

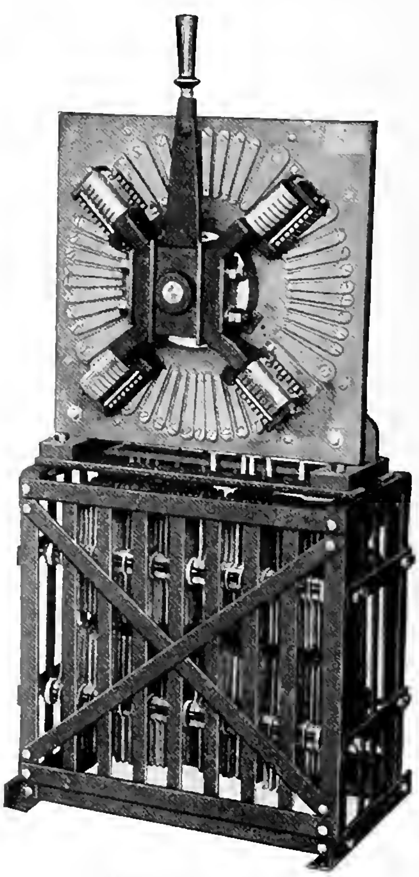
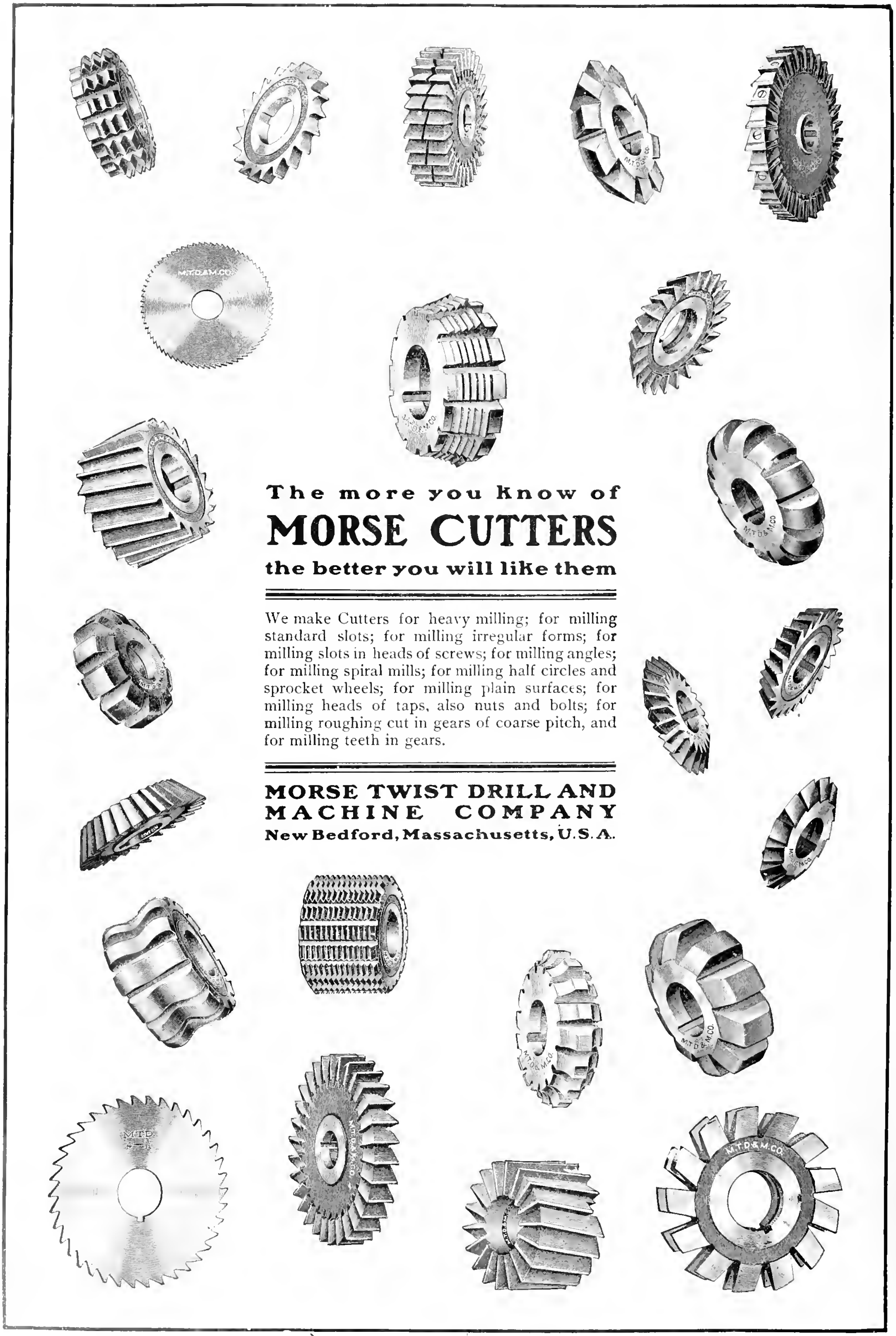


Fig. 2. Crane Controller, Types B and C.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We make Cutters for heavy milling; for milling standard slots; for milling irregular forms; for milling slots in heads of screws; for milling angles; for milling spiral mills; for milling half circles and sprocket wheels; for milling plain surfaces; for milling heads of taps, also nuts and bolts; for milling roughing cut in gears of coarse pitch, and for milling teeth in gears.
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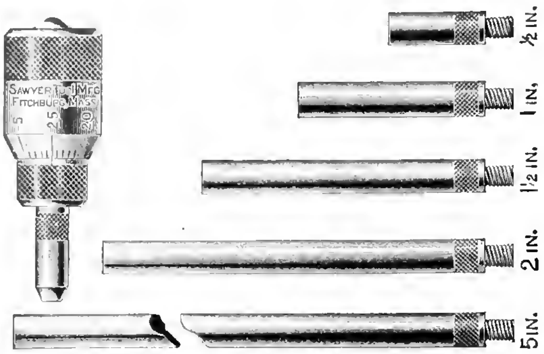
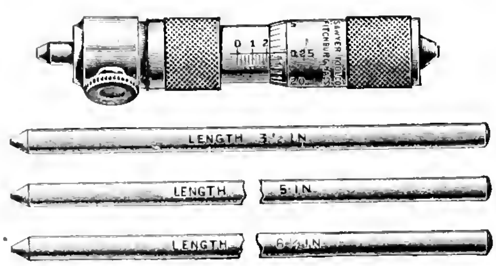


No. 144, the smallest and neatest Inside Micrometer made, measures accurately by thousandths or fractions, from $1\frac{1}{2}''$ to $12\frac{1}{2}''$. List price $4.00.



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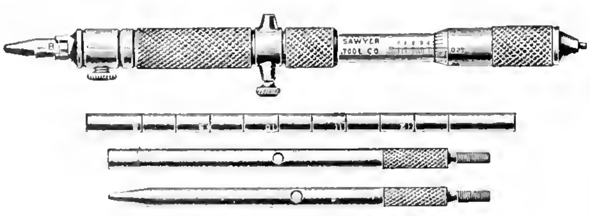
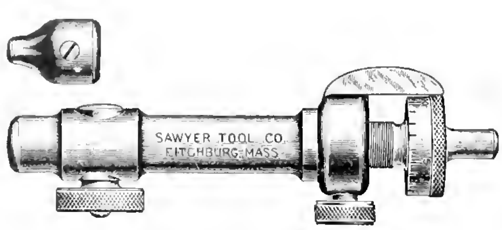


No. 140 measures from $8''$ to $23''$, as shown. With extra $5''$ rods its capacity can be increased to almost any length. It has our improved telescoping arrangement which is very handy. List price $4.00.



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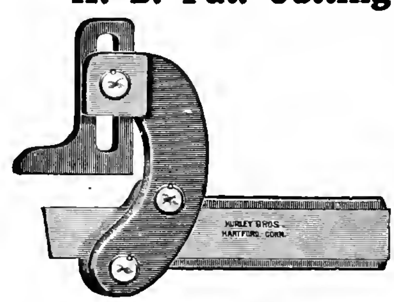

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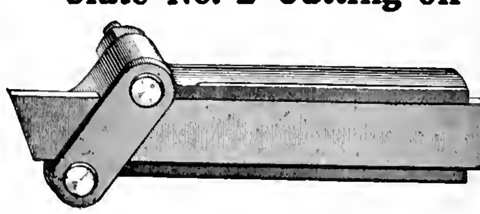

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Also **Crescent Cutting-off Tools.** Straight shanks, no projections, for screw machine use. No. 2, $1\frac{1}{4}\text{x}\frac{1}{2}''$. No. 3, $1\frac{7}{16}\text{x}\frac{5}{8}''$ shank. No. 2 blades $\frac{7}{8}''$ wide. No. 3, $1''$ wide, all thicknesses. For sale by supply dealers, or

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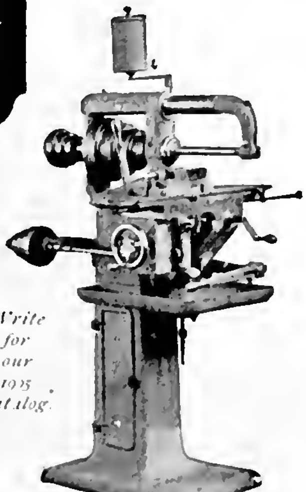

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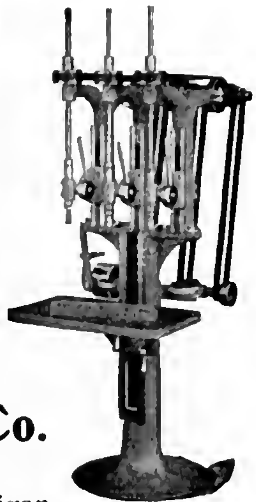

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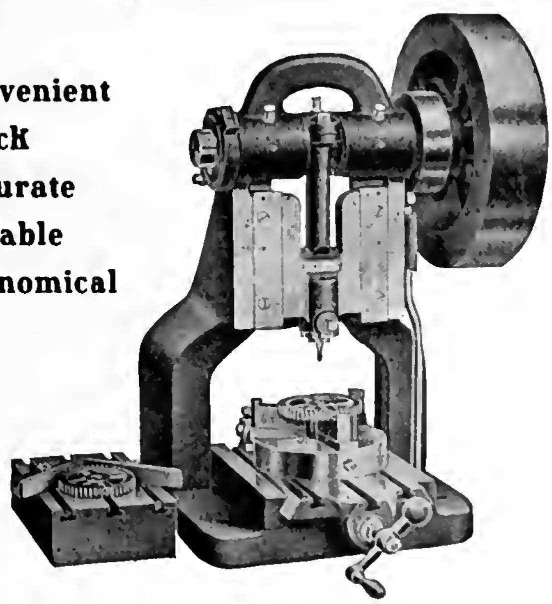

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Equipped with sliding table and sub table with V block. Countershaft is also supplied, and we are prepared to furnish a suitable pedestal if required, also chuck for holding work. This is a very handy tool for light work in shops having internal key seating to do.

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(PATENTED)

If you are sick and refuse the medicine that will help you, even your friends will soon lose patience. If you are wasting time and money through trouble with loose pulleys and friction clutches, if your belts are being slowly but surely ruined with the oil these same pulleys throw off as soon as speed gets up, if your floors and walls are oil-soaked —increasing the fire risk—goods damaged by oil stains, if one man's time is almost completely needed to look after the oiling of the pulleys—you are entitled to sympathy, but only until you can procure the remedy for all these ills.

Arguto Oilless Bearings

straighten out the loose pulley troubles in short order. They need no oil, no attention. Keep the center of a loose pulley running at highest speed cool and free from friction, are noiseless, durable—the right thing in the right place, and we can promise prompt delivery.

Send us a trial order. Catalogue for the asking.

Arguto Oilless Bearing Co.
Wayne Junction, Philadelphia, Pa.

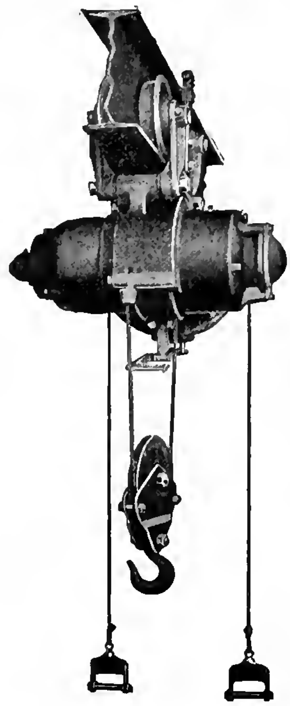
The Very Science of Hoisting

is condensed and embodied in the Yale & Towne Triplex Block. It outlifts, outlasts, outclasses in speed, ease and safety any other style of chain block made. It is adapted for every kind of hoisting—in the machine shop, the railroad shop, the factory, the foundry; wherever heavy loads must be handled the "Triplex" is needed.

Send for Catalogue.

The Yale & Towne Mfg. Company
9-15 Murray Street,
New York.

It Requires Less Power



to operate the

SHEPARD ELECTRIC HOIST

than any worm driven hoist.

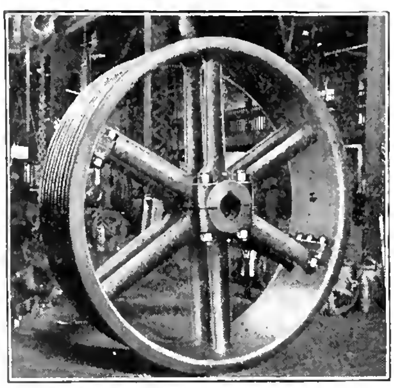
SPUR GEARS

running in a bath of oil give it the highest efficiency, and all the essentials of the hoisting apparatus of the Modern Traveling Crane are combined in this simple and compact machine.
All parts enclosed but easily accessible; wide speed variation.

Bulletin No. 56 gives full description.

The General Pneumatic Tool Co.
Montour Falls, N. Y.
New York, 149 Broadway. Philadelphia, Stephen Girard Bldg.

Power-Transmitting Machinery

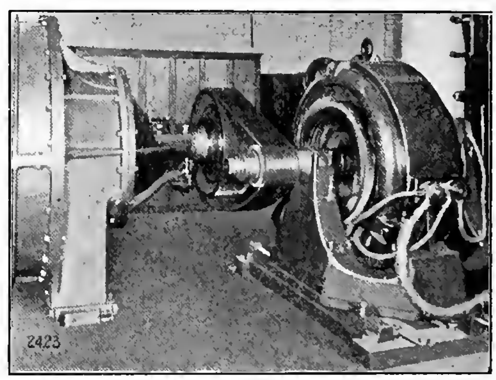


We manufacture and install complete rope drives. Our machine-molded sheaves are perfect in balance, accurately finished and free from flaws injurious to the rope. Rope drives designed by us are successful. Poor design means failure.

We cast and finish Sheaves—all sizes—English or American system, Pulleys, Band Wheels, Fly Wheels, Gears, Sprocket Wheels, etc. We manufacture Shafting, Pillow Blocks, Hangers, Floor Stands, Elevating and Conveying Machinery, etc.

Headquarters for Supplies.

H. W. Caldwell & Son Co.
Chicago, Western Ave., 17th-18th St.
New York, 95 Liberty Street.
Woodward, Wight & Co., Ltd., New Orleans.



Renold Silent Chain

Photographed when operating at Full Speed

on H. P. drive to blower, at R. H. Macy & Co.'s Store New York City

The clean-cut curves and non-slipping action shown in the picture are secured by the use of Spring Center Wheels, which absorb the pulsations of the engine and correct variations of angular velocity.

New Circulars 50 and 51 add new experiences to the information contained in Booklet "Y." All three for the asking. Write today.

New York, 49 Dey St. — **LINK-BELT ENGINEERING CO.** PHILADELPHIA — Pittsburg, Park Bldg.
Chicago — **LINK-BELT MACHINERY CO.** — Chicago

When Seeking Quality and High Efficiency

COMBINED WITH

SYMMETRY of DESIGN

BEAR IN MIND THAT

PAWLING & HARNISCHFEGER

Milwaukee, Wisconsin,

BUILD

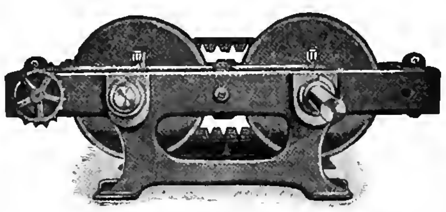
ELECTRIC TRAVELING CRANES
TRAVELING ELECTRIC HOISTS

AND

Horizontal Drilling and Boring Machines

THAT FULFILL THESE SPECIFICATIONS

Reeves Variable Speed Transmission

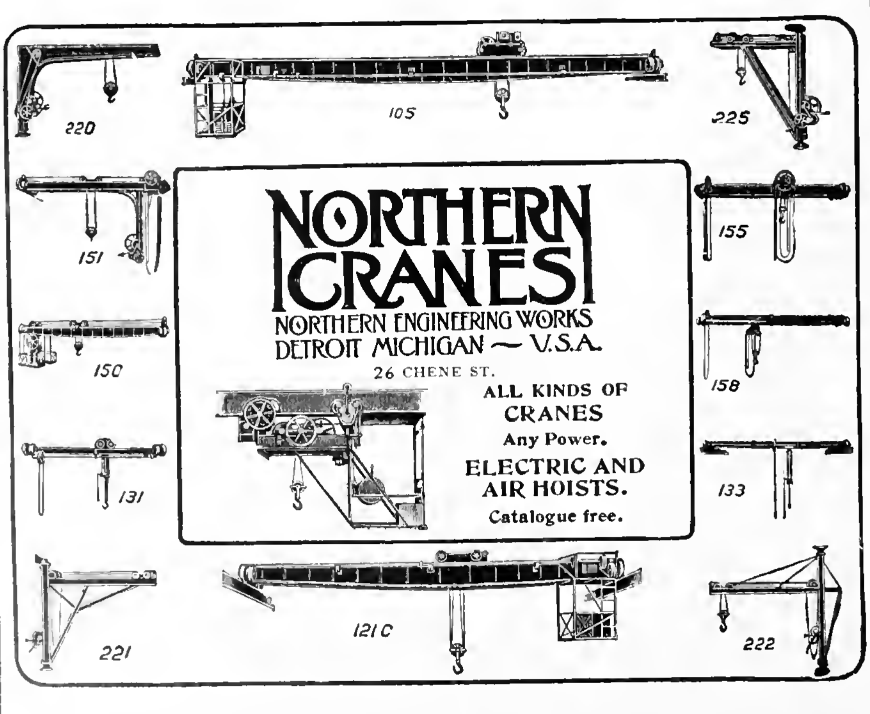


Equips your machines to meet every speed demanded for modern work. High speed, low speed and every between speed instantly obtainable without stopping the machine or shifting a belt. It's a time saver, a money saver, and applicable to all classes of machines requiring variable speed.

Built in sizes to suit all conditions.

Book for the asking.

REEVES PULLEY COMPANY, Columbus, Ind., U. S. A.



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NORTHERN ENGINEERING WORKS
DETROIT MICHIGAN — V.S.A.
26 CHENE ST.

ALL KINDS OF CRANES

Any Power.

ELECTRIC AND AIR HOISTS.

Catalogue free.

THE CURTIS
Light Bridge Crane
with
Curtis Air Hoists

AIR HOISTS IN STOCK
PNEUMATIC ELEVATORS
AIR COMPRESSORS

Curtis & Co. Mfg. Co., St. Louis

AGENTS: Walter H. Foster, New York. Hill, Clarke & Co., Boston. Baird Machinery Co., Pittsburg. Strong, Carlisle & Hammond, Cleveland.

You get more hard service out of a Philips Pressed Steel Pulley than from a dozen ordinary pulleys put in one

The "Philips" is built for strength, to withstand strain, and for long wear. Its construction is a perfect blend of science and practice. All parts are interlocked, making the pulley practically one piece from the massive hub to the light but strong rim.

Write us for details, we make a full line of sizes.

Philips Pressed Steel Pulley Works,
Fourth St. and Glenwood Ave.
Philadelphia, Pa.

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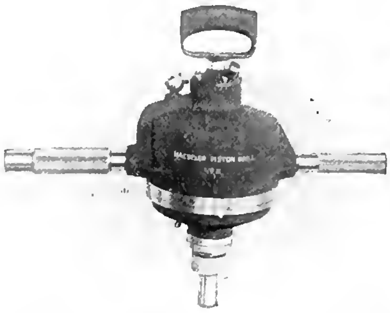
7 Holders in 1 with an assortment of **22 Tools & Fixtures**

Catalog and particulars sent on request.

O. K. Tool Holder Co., Shelton, Conn., U. S. A.

AIR DRILLS

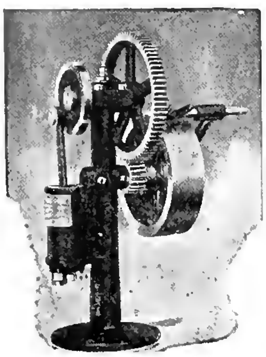


FOR DRILLING,
REAMING, TAPPING,
FLUE EXPANDING,
BORING, ETC.

Superior in design, material and workmanship. A three cylinder, balanced, reciprocating piston motor with no vibration at any speed. A single valve controlling admission and exhaust to all three cylinders.

THE INGERSOLL-SERGEANT DRILL CO.

CHICAGO, ILL. CLEVELAND, O. PITTSBURG, PA. PHILADELPHIA, PA. **26 Cortlandt Street, New York.** BOSTON, MASS. MEXICO CITY, MEX. ST. LOUIS, MO. EL PASO, TEX. K13



AIR COMPRESSORS

BELTED - DIRECT CONNECTED - HAND - POWER

SINGLE AND THREE CYLINDER STYLES.

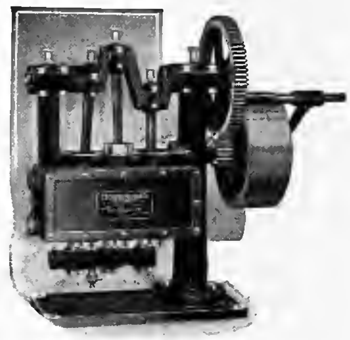
Capacities 1 to 30 cubic feet free air per minute.

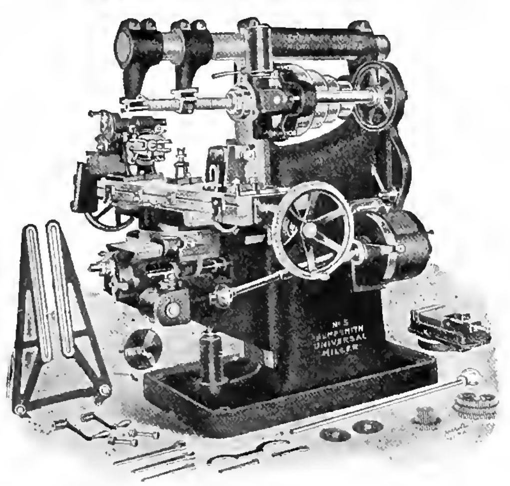
Write for Catalogue.

THE F. W. SPACKE MACHINE CO.

INDIANAPOLIS, IND., U. S. A.

GEAR CUTTING We maintain a special department for this division of our business. Let us furnish estimates.





No. 3 Universal Miller. All feeds positive and automatic.

THE KEMPSMITH MILLER

—the type of what is best in design and reliable in workmanship, in milling machine construction. New and modern throughout, with late improvements increasing its working qualities.

Catalog is just out and is of value, if interested.

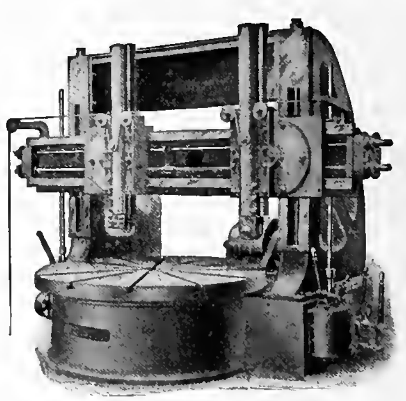
THE KEMPSMITH MFG. COMPANY
Milwaukee, Wis., U. S. A.

EUROPEAN AGENTS: Selig Sonnenthal & Co., London, E. C.
AGENTS FOR HOLLAND: R. S. Stokvis & Zonen, Rotterdam.

Poole Boring Mills for Heavy Work

Exceptionally strong and rigid; ample weight given to all parts; adapted to make the most efficient use of high speed steels. Every improvement for convenient operation. The cone pulley is mounted between the housings on these machines, making them particularly compact; all gears are enclosed. Belt or motor drive as desired.

Built in 6, 7, 8 and 10 ft. sizes. Write for Bulletins.



The J. Morton Poole Co., Wilmington, Del.

AGENTS—Prentiss Tool and Supply Co., 115 Liberty St., New York, 145 Oliver St., Boston, 507 D. S. Morgan Bldg., Buffalo. Hill, Clarke & Co., Chicago. W. C. Johnson & Sons Mchy. Co., St. Louis. Tatum & Bowen, San Francisco.

The Williams Electric Clutch and Safety Device

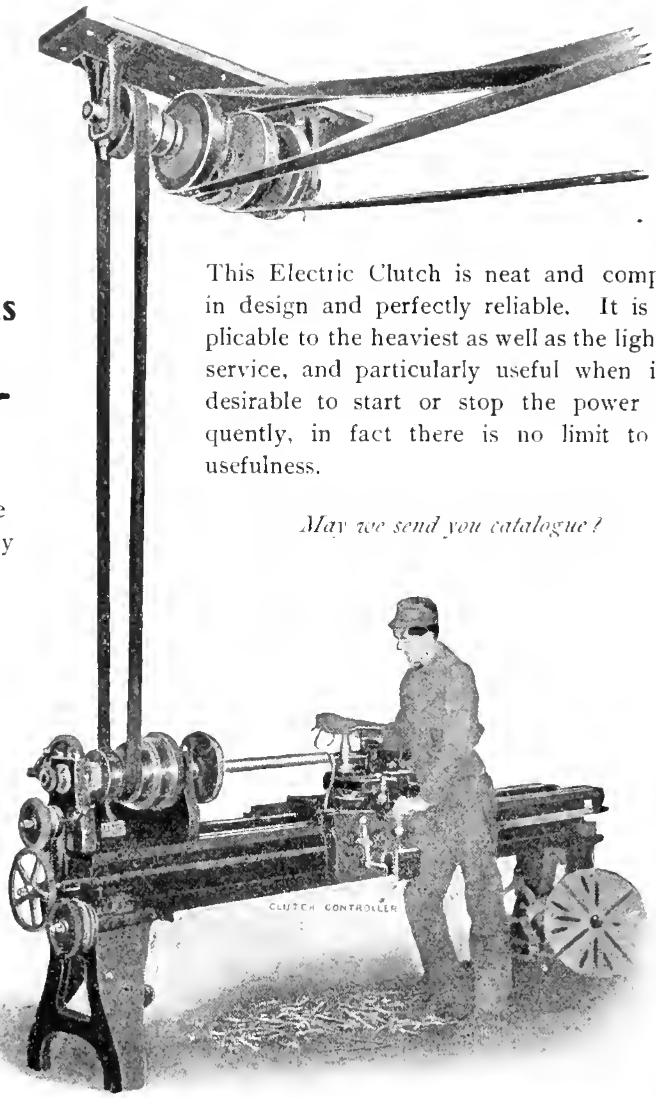
Gives absolute control over machinery in every part of the factory. The entire plant may be instantly shut down, or any department started or stopped independently of the others. It is a saver of time, power, needless wear and tear on belts and shafts, and is a safeguard against accident to men or machines.

24-inch Engine Lathe

equipped with

Williams Electric Counter-shaft

Any machine so driven may be stopped instantly or gradually at the will of operator.



This Electric Clutch is neat and compact in design and perfectly reliable. It is applicable to the heaviest as well as the lightest service, and particularly useful when it is desirable to start or stop the power frequently, in fact there is no limit to its usefulness.

May we send you catalogue?

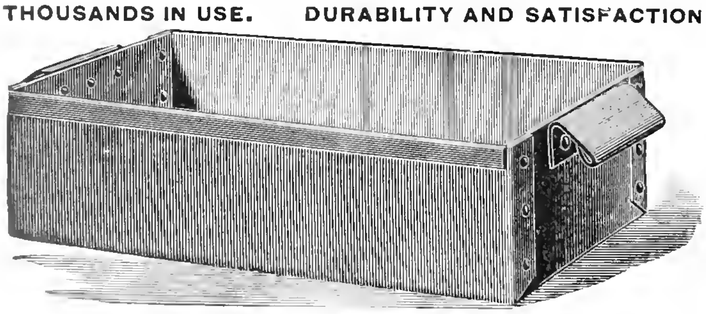
The Williams Electric Machine Co., Akron, Ohio

Also manufacturers of Lifting Magnets, Electric and Mechanical Clutches.

Pressed Steel Shop Pans or Tote Boxes

For Machine Shops and Foundries, Bolt Works, Etc.

THOUSANDS IN USE. DURABILITY AND SATISFACTION GUARANTEED.



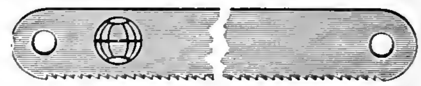
Made of any Gauge of Sheet Steel desired; never go to pieces as the common riveted boxes do, and always give entire satisfaction. Try samples and you would not be without them in your works at any price.

Size "K" No. 16 Gauge.

Suitable for handling bolts, rivets, nails, screws, nuts, washers, castings, ore, quartz and other substances, and for use under lathes and drill presses to catch the turnings, trimmings, borings, oil drippings, etc. Send for Catalogue.

KILBOURNE & JACOBS MFG. CO., COLUMBUS, OHIO.

These Saws Stand the Test



The proper way to test Hack Saw Blades is to cut off pieces from the same bar of steel, changing the blades to be tested on each alternate cut. Keep an accurate record of the time consumed by each blade in performing the work and the number of cuts each blade makes. If the weight or pressure on the blade is changed it should be made so as to effect both saws alike. This is the kind of test we solicit for the

Universal Hack Saw Blades.

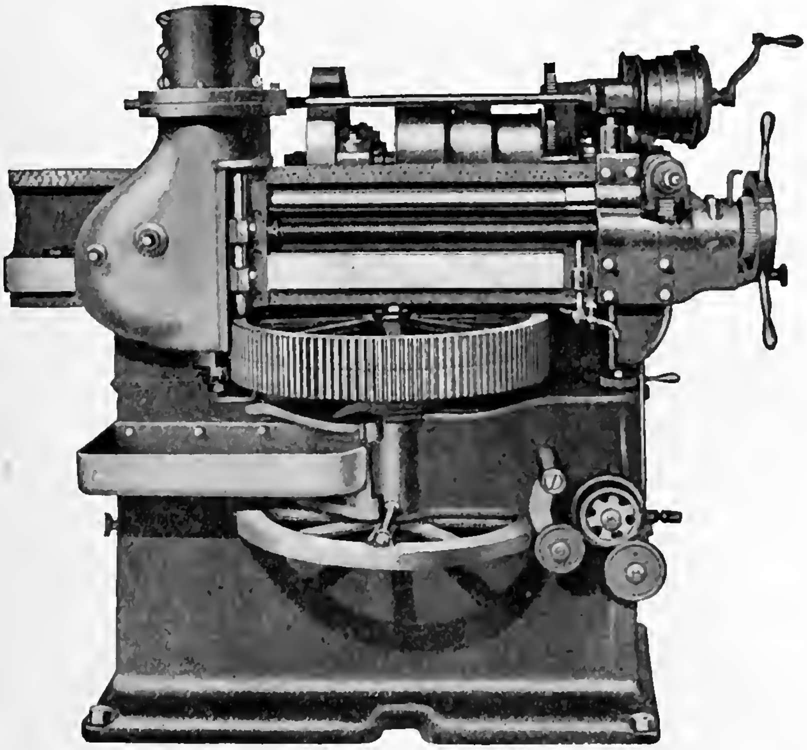
We only ask a fair trial and if we cannot then convince even the most hardened unbeliever that our blades are all we claim for them—we have nothing more to say. Your dealer will furnish them on your order. Send for circulars and prices.

West Haven Manufacturing Company,

NEW HAVEN, CONN., U. S. A.

Sole Agents for Export,
The Fairbanks Co., Broome and Elm Sts., New York.
78-80 City Road, London, E. C., Eng.

Let Us Help You Reduce the Cost of Your Gears.



Compare Gear Shaper time with your present methods and your order will be ours. This has been our usual experience, especially where quality was concerned.

REMEMBER the Gear Shaper shows a saving of 25 to 50 per cent. in cutting time, and produces smooth running gears.

REMEMBER a generating cutter is used, only one being required for each pitch.

REMEMBER the Gear Shaper will plane internal and cluster gears with but little clearance under the teeth.

REMEMBER our Gear Cutting Department is at your service.

Send us prints for Gear Shaper time even though you are not in the market.

THE FELLOWS GEAR SHAPER COMPANY, 23 Pearl St., Springfield, Vermont, U.S.A.

FOREIGN AGENTS—Henry Kelley & Co., Manchester, England. M. Koyemann Dusseldorf, Germany. Ph. Bonvillain, Paris, France. White, Child & Beney, Vienna, Austria. Walter S. Stone & Co., Yokohama, Japan.

Don't Lose Your Temper!

The Goodell-Pratt Hack-Saws never do. They are too well tempered for that. Tempered in the most approved way. Made from the finest quality of hot-rolled sheet steel. Sharpened and set by a peculiar process of our own. They cut easily and rapidly. Last long.

What other qualities can you ask for in a Hack-Saw? No other Hack-Saw contains so many good qualities as you will find in the Goodell-Pratt.

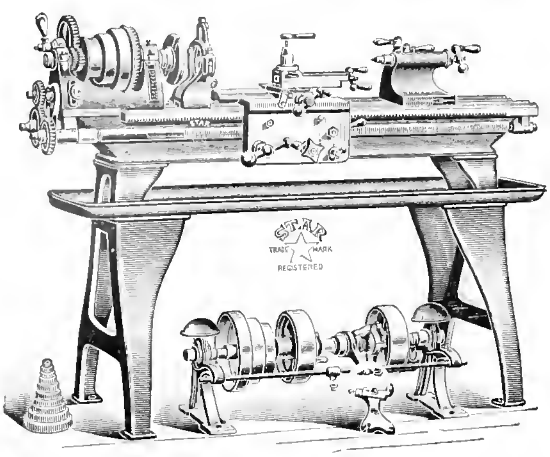
Always look for this mark G on a Hack-Saw. It's like an insurance policy. It assures you that it was made by the celebrated

GOODELL-PRATT COMPANY,

GREENFIELD, MASS., U. S. A.

A "Star" Lathe

MOUNTED ON OIL-PAN



makes the finest kind of a lathe for the model-maker, gunsmith, electrical and repair work, and fine, accurate machine-shop, tool-room and laboratory service, where precision, convenience and durability are essential. Prices are moderate. Sizes 9, 11, 12, 14, 16 inch swing.
We also make **Bench Lathes, Foot Lathes, Speed Lathes, Wood Turning Lathes.**

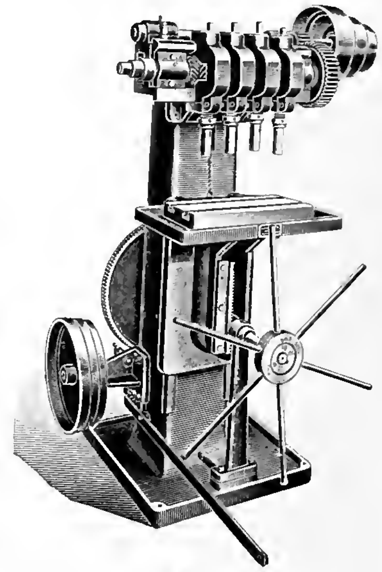
Send for Catalog "B."

The Seneca Falls Mfg. Co.

330 Water Street, Seneca Falls, N. Y., U. S. A.

85A

Spiral Geared Gang Drills



Efficient Durable Convenient

Spindles are driven by spiral gears which mesh into a spiral gear running entire length of head, permitting any adjustment of spindles without reference to drive. The No. 5 drill, shown above, has capacity up to 5/8" drills, 2½" apart with single spiral, and 1¾" with double spiral.

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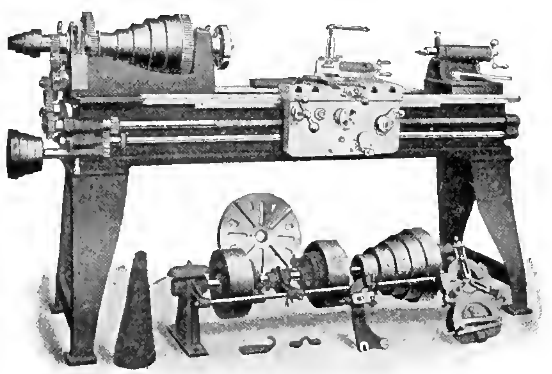
MOLINE TOOL COMPANY, Moline, Ill.

We Make Lathes a Specialty



Write for description of

New 15-inch Engine Lathe

with Instantaneous Change Gear Device

This improved tool will interest you

Von Wyck Machine Tool Co., Cincinnati, O.

OUR SPECIALTY,

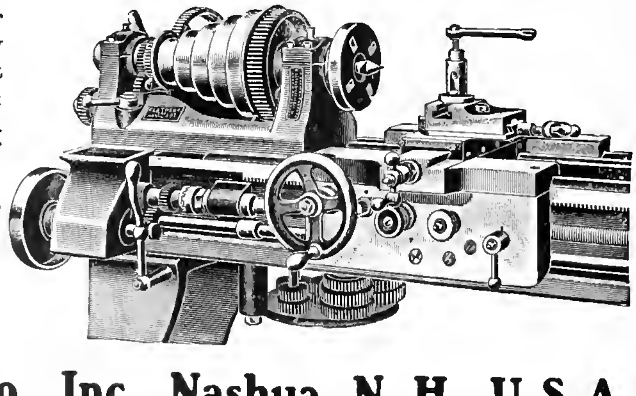
Automatic Machinery for making Wood Screws.

Asa S. Cook Co., HARTFORD, CONN., U.S.A.

The New Model Flather Lathes

Are the tools for modern work. They are built to turn out accurate work in quick time; have all the good points of lathe construction, and are made in sizes from 14-inch to 30-inoh swing.

Our Catalogue will be sent on request.



Flather & Co., Inc., Nashua, N. H., U.S.A.

AGENTS—Hill, Clarke & Co., Boston, New York and Chicago. Chas. Churchill & Co., London, Birmingham, Manchester, Glasgow. Alfred Herbert, Ltd., Paris. V. Lowener, Copenhagen, Stockholm, Christiania.

Second Hand Machine Tools

IN THE PLANT OF
CRESWELL & WATERS CO., Nicetown, Philadelphia.

Must be Sold at Once.

LATHES.

14x6 Plain, Johnson.	20x8 Plain, Harrington.
16x6 Plain, Harrington.	23x10 Plain, Thomas.
18x8 Plain, Harrington.	24x8 ft. 6 in. Plain, Harrington.
19x12 New, Harrington.	21-48x8 Gap, Harrington.
19x12 New, Johnson.	31 in. Putnam Pulley Lathe.

PLANERS.

16x16x3 New Haven.	36x36x9, 1 hd, New Haven.
22x22x6 Harrington.	36x36x9, 1 hd., Sellers.
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DRILLS.

16 in. Sta. hd., Harrington.	24 in. Sli. hd., Wheeler.
20 in. Sta. hd., Prentice.	2½ ft. Semi-Radial, Hilles & Jones.
22 in. Sli. hd., Kelly.	3 ft. Semi-Radial, Hilles & Jones.

MISCELLANEOUS.

No. 1 B. & S. Plain Screw Mach.	6 in. New Belt Lacing Mch. Diamond.
2x24 Trip G., Warner & Swasey.	Grinding Machines.
9 in. Traverse Hd., Shaper.	No. 6 Vertical Miller, New, B. B.
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2 in. Bar Kelley Boring Mill.	4½ in. Cut Off Mch., Starr.
	4 in. Pipe Mch., Armstrong.
	Polishing Machines.

Send for complete list with prices.

Miscellaneous Department,
NILES-BEMENT-POND COMPANY,
111 Broadway, New York City

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UNIT LINK BALL BEARING FLEXIBLE SHAFT

Is appreciated more and more every day.

Bring your tools to the work and save the labor of carrying heavy work to the tools.

1-10 H.P. or 150 H.P. all the same to us.

Motor equipment of all kinds for flexible transmission.

"Tell us what you want; we'll tell you what we have."

Send for Bulletin 18-A.

Coates Clipper Manufacturing Company

Worcester, Massachusetts

London Office, 14 Thavies Inn, Holborn Circus

Single and Multiple Upright Drills

Noted for Rapid Work and Accuracy.

Built of best materials, from new designs, all improvements.

Engraving shows the 2, 3, 4 and 5 spindle style, belt driven. All pulleys turned inside. Spindle pulleys run on stationary sleeve and do not wear the spindle out of line. *Ball bearing thrust collars on all spindles.* Table raised and lowered by screw.

We make 30 styles and sizes of upright drills.

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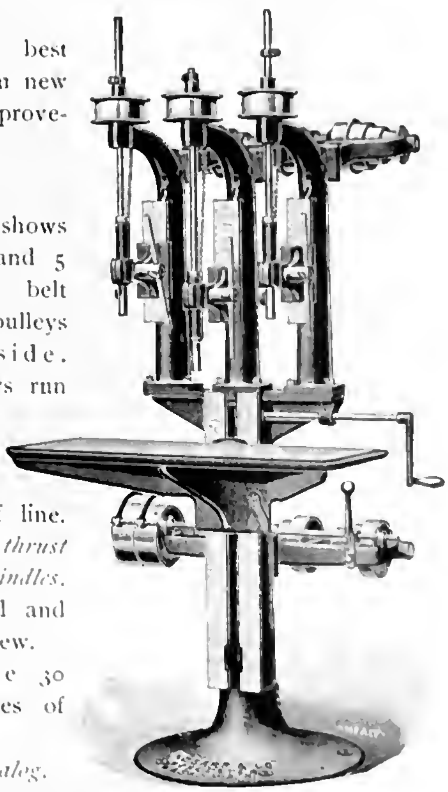
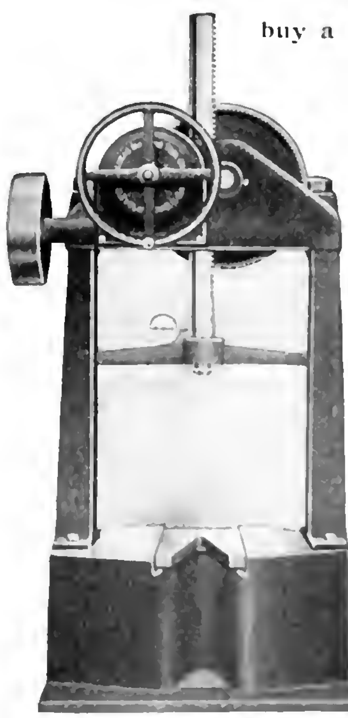


H. G. BARR, WORCESTER, MASS.

DON'T BUY COAL but

save your money and

buy a **Lucas Power Forcing Press**



The coal necessary for

ONE

"shrink fit" if put under the boiler, would furnish enough power to make

HUNDREDS

of

FORCE FITS

on our

PRESS.

You also save refinishing and polishing, uncertainty (the gauge tells) and *time*.

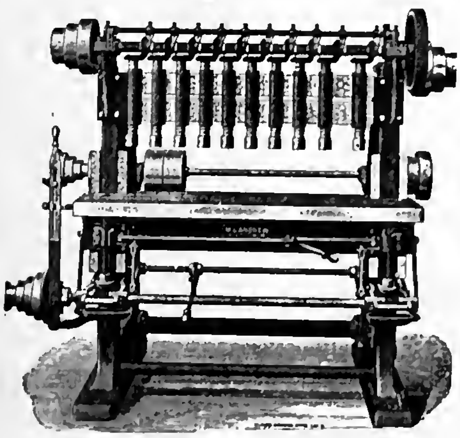
Lucas Machine Tool Co.

Cleveland, Ohio, U. S. A.

AGENTS: Hill, Clarke & Co., Boston, Chicago; W. M. Pattison Machinery Co., Cleveland; Pacific Tool & Supply Co., San Francisco; C. W. Burton, Griffiths & Co., London.

The Andrew
Multiple Drilling Machine

Patented.

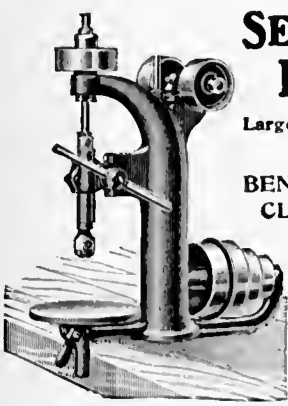


AN up-to date, labor saving tool for light or medium drilling, especially adapted for agricultural machinery. All spindles are adjustable and can be easily changed to different positions. Table has both hand and power feed and quick return stroke.

We build machines of any capacity from 1 to 50 spindles, to drill as close as 7/8" center to center, on a straight line, grouped in different forms or staggered.

May we send further details?

M. L. Andrew & Co.,
Cincinnati, Ohio.



SENSITIVE DRILLS

Large Line. Power or Lever Feed.

BENCH DRILLS,
CLAMP DRILLS,
PLANER CHUCKS.

Francis Reed Co.
Worcester, Mass.

WE MANUFACTURE

SHAPERS

EXCLUSIVELY.

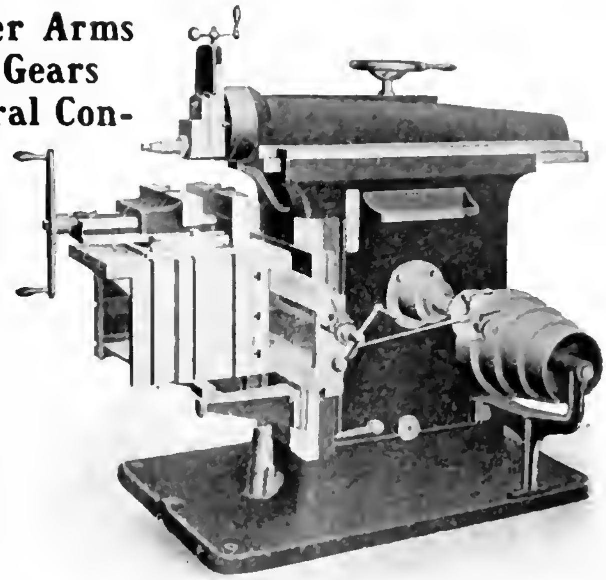
12 TO 32 INCH STROKE.

SMITH & MILLS,
Cincinnati, Ohio, U. S. A.

Heavy Rocker Arms
Large Main Gears
Strong General Construction

are all points that help to make

Kelly Shapers



the powerful, accurate, efficient machines they are everywhere conceded to be.

Crank Shapers Exclusively

15", 17", and 20" Plain.
16", 20", 24' and 26" Back geared.

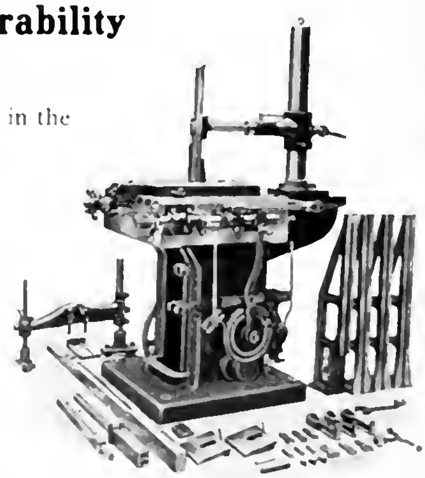
New Catalogue shows full line.

THE R. A. KELLY CO., - Xenia, Ohio

Rapidity, Accuracy, Durability and Ease of Operation

are the features most prominent in the

Morton Key Seater



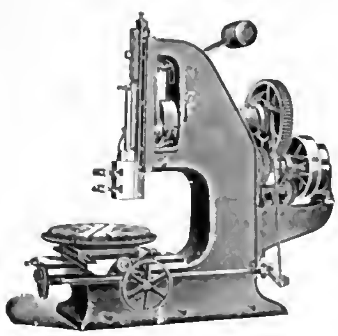
It centers the work by the bore and can be set to cut a keyway of a given size and taper, without a rule and before it is placed on the machine. Built in sizes 8", 18", 24", 30" and 48" stroke.

Investigate the Morton.

MORTON MFG. COMPANY
Muskegon, Heights, Mich.

NEW HAVEN MFG. COMPANY,

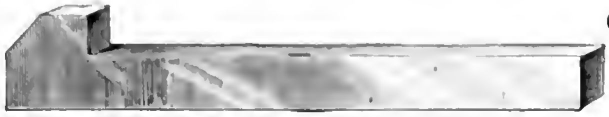
NEW HAVEN, CONN.



MANUFACTURERS OF

SLOTTERS, PLANERS, LATHES, DRILLS, ETC.

Finished Machine Keys

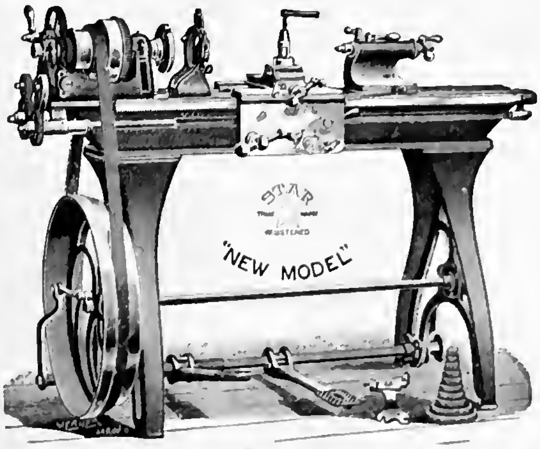


Gib and Plain Head.

All sizes carried in stock.
Write for discounts.

OLNEY & WARRIN,
66-68 Centre St., New York.

Cheaper than you can make them. Finished "Ready to Drive."



11 In. x 5 ft. "Star" Foot Power Lathe.

It's Just as Good as a "Star" Lathe

is an expression often made by our competitors, showing the high standard of quality that they place upon our Lathes

The "Star" Foot and Power Lathes, 9 to [illegible] inch swing, are built to be absolutely excellent in every detail first—after that built to sell by reason of their merit

They have Automatic Cross Feed, with or without compound rest, taper, draw-in chuck, milling and gear-cutting attachments, friction countershaft, metric lead screw, etc.

Full details furnished on request. Send for Catalog "B."

The SENECA FALLS MFG. CO.
330 Water St., Seneca Falls, N. Y., U. S. A.

Combination of
Stow Flexible Shaft
and
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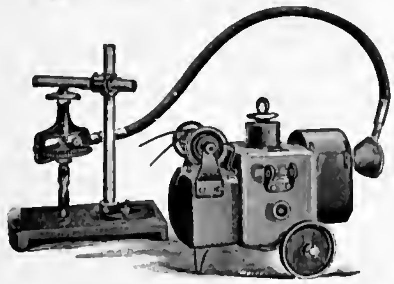

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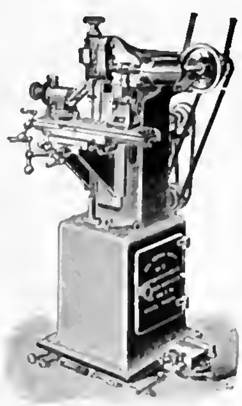

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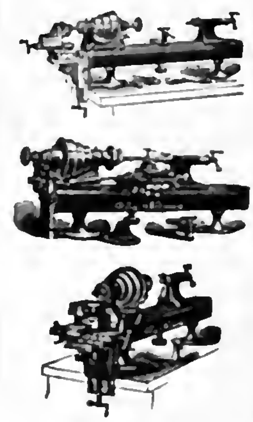

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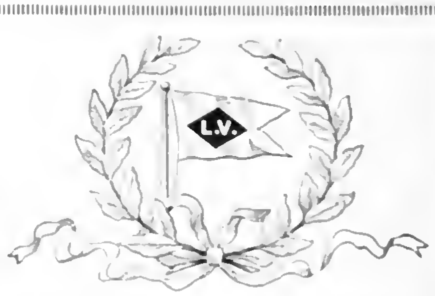

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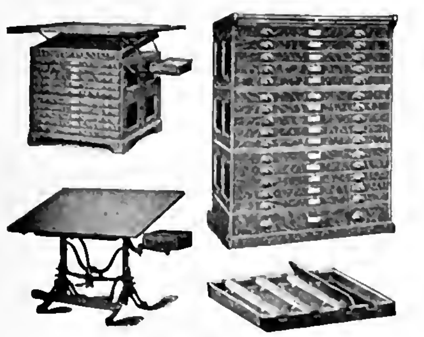

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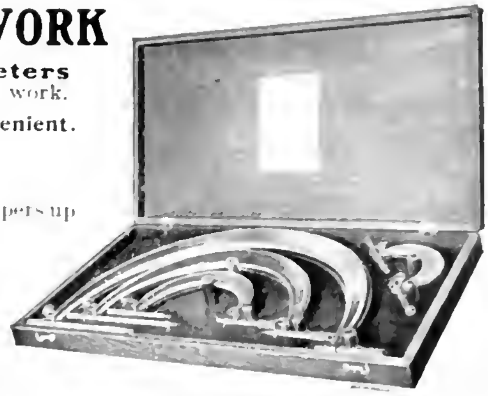

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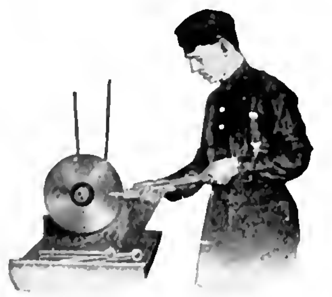

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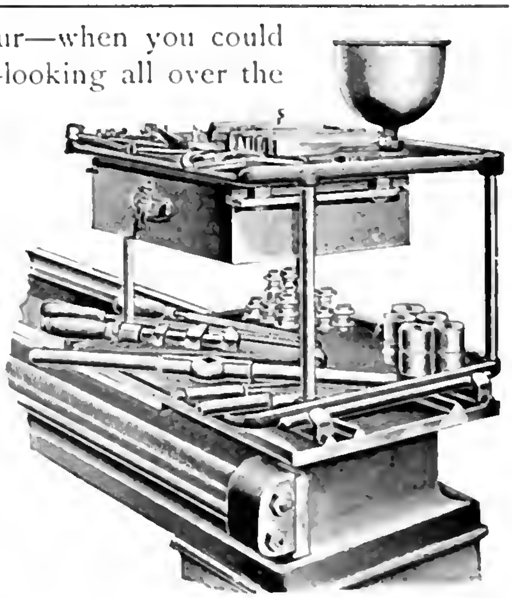

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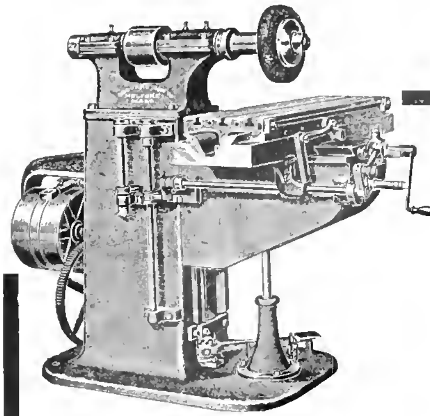

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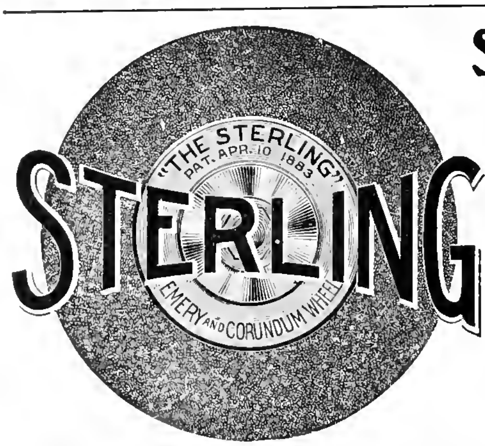

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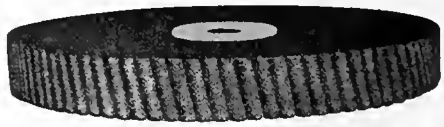

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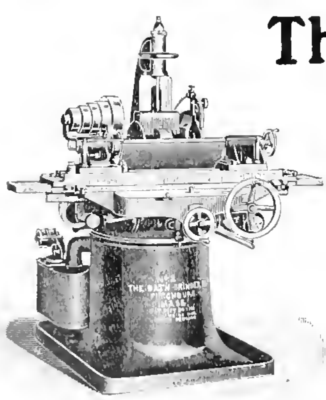

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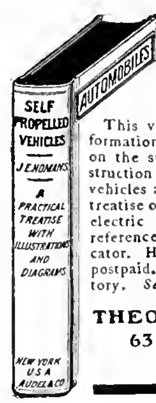

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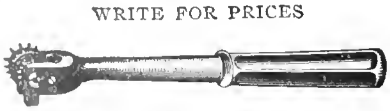

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This is accounted for by the fact that the almost pure corundum used in these wheels permits so much faster and cleaner cutting that the work is completed before enough friction is created to produce heat.

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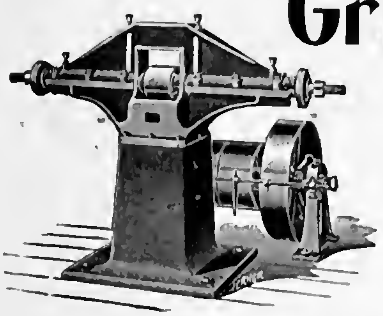

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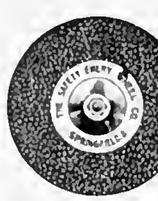

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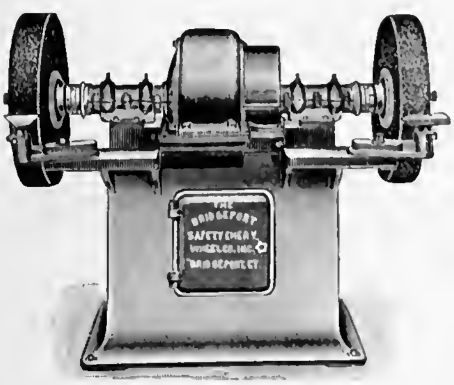
Adler & Eisenchitz, Milan, Italy.
Defries & Co., Act. Ges., Berlin, Dusseldorf.

THE SAFETY EMERY WHEEL COMPANY, Springfield, Ohio, U. S. A.



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Motor built to fit the machine.
Large spindles, special ring oiling bearings.
With or without hoods.
Motor driven tool grinders and buffing lathes.

Also Full Line of Belt Driven Grinders.

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BETTER than a Black Diamond for keeping your tool room Emery Wheel true. Cheaper, easier to keep track of, and durable to the last degree. A tool room necessity. In use in many of the largest manufacturing concerns in the country. *Booklet of Testimonials, etc.*

Price List and Length of Dresser.
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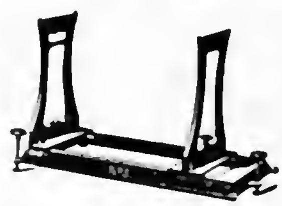

Compare this with the old way—ten to twenty minutes saved, and results certain.

Bowsher's Patent Balancing Way

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Made in 3 sizes and styles, for bench and floor use. Ways chilled and ground, spirit levels attached.

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MANUFACTURERS OF
Wood Leather covered Wheels, Bull Neck Leather Wheels, Sheepskin, Walrus, Canvas, Felt and Paper Wheels. Buffs. *Write for prices.*

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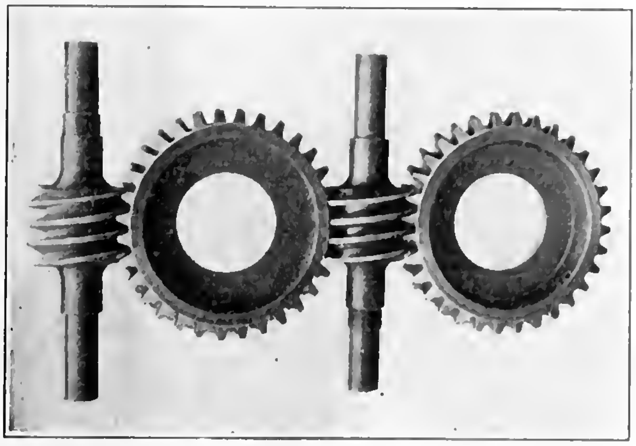

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Submit your inquiries and we will give you the benefit of our engineering experience in the practical application of worm gearing.
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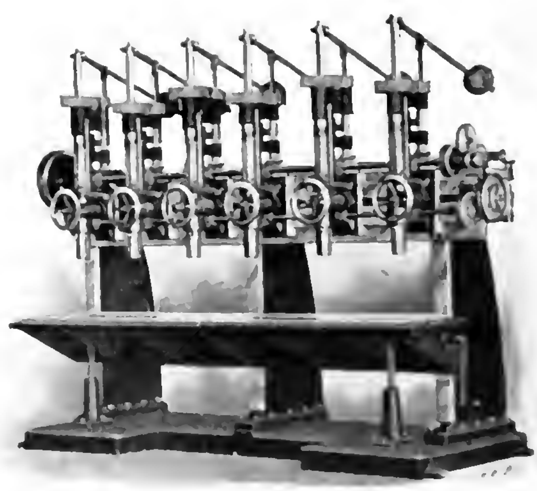
This No. 5 Independent Feed Multiple Drill will drill Six 2-inch holes simultaneously.



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VERTICAL TURRET BORING AND TURNING **MACHINES**

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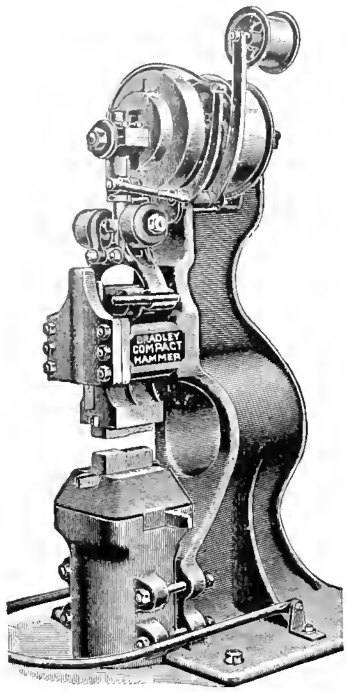

If your forging is of a general, all around jobbing character with frequent variations in the size of stock, or

If it is of such a nature that the hammer is not working continuously, but with frequent stops, or

If your floor space is limited but with good height, a Bradley Compact Hammer would prove a money maker.

It is compact in design, occupies but little space and can be run at high speed.

As it weighs considerably less than our regular Upright Hammer its price is much less.

Made with head weighing 15 to 200 pounds.

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The Bradley Cushioned Helve Hammer.
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Forges for Hard Coal or Coke.

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BUY **"American Pioneer" Pressed Steel Shaft Hangers**

and you **SAVE MONEY**

Because

They are cheaper than any other—and the cost of putting them up is more than cut in half—so is the freight.

Made in the following sizes:
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Sold by supply houses throughout the United States and Canada.

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Rigid
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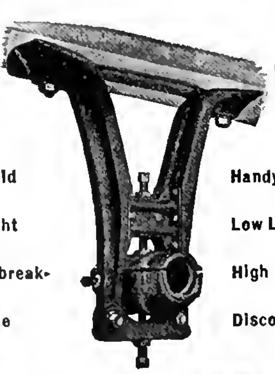

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(PATENTED)

FORGED FROM BAR STEEL

Out-Pulls and Out-Wears Wrought Chain of Equal Size.
½ Inch Link Pulled 14,800 lbs. Under Test. Sizes from ¼ to 1 Inch

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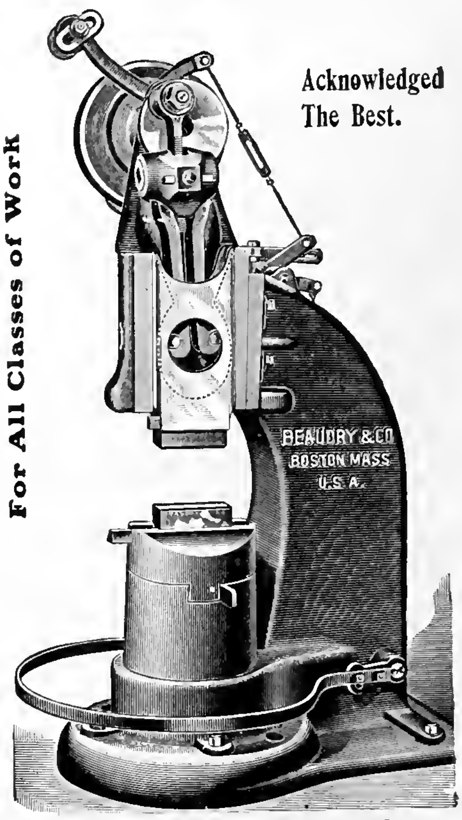
Open.

Shut.

The Beaudry Champion Power Hammer.

For All Classes of Work

Acknowledged The Best.



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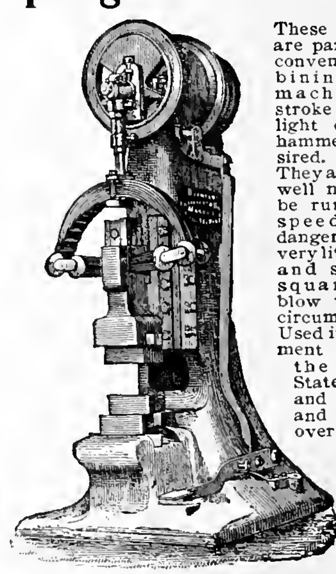

These hamme are particularly convenient combining in one machine the stroke of a very light or heavy hammer as desired.
They are strong, well made, can be run at high speed without danger, require very little power and strike a square, true blow under all circumstances.
Used in government shops by the United States, France and Russia, and sold all over the world.

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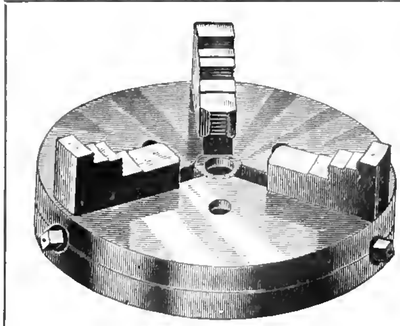
Established 1864.



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The Horton Lathe Chuck

is the cheapest in the end.

IT IS CELEBRATED THE WORLD OVER.

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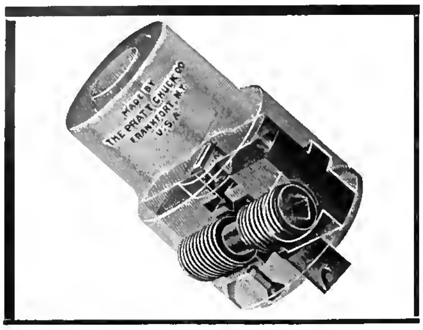

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The PRATT CHUCK

Will—
Hold What?
Those High Speed Drills
No other chuck will.

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Sole English Agency, Selig, Sonnenthal & Co., London, who keep a large stock.

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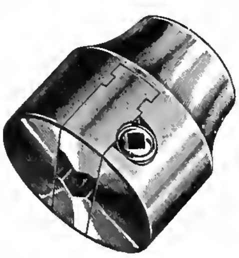

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One part is as strong as another. Outwears any other kind of chuck. Made right and sold at the right price. Circulars and price lists mailed on request.

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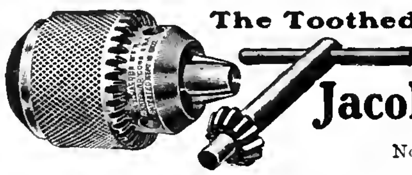

The Toothed Sleeve and Key is the feature

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No twisting of spindle when tightening drill.

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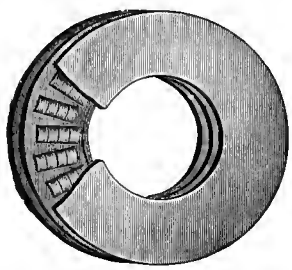

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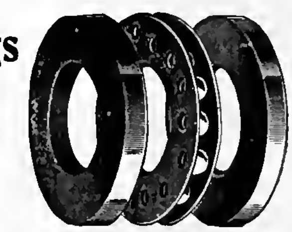
Antifriction Bearings of all Descriptions.



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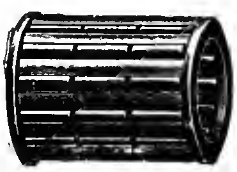

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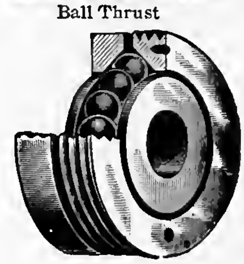

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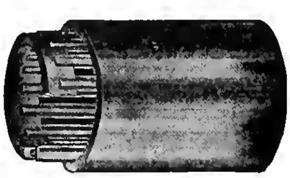
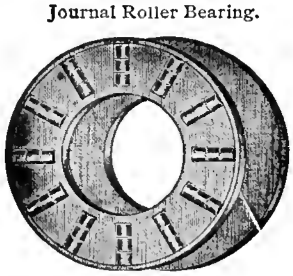


Journal Roller Bearing.



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Standard Roller Bearing Company.

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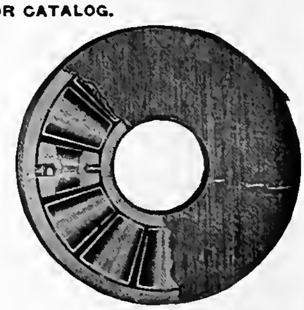
TAPERED ROLLER THRUST BEARINGS
SAVE POWER AND OIL



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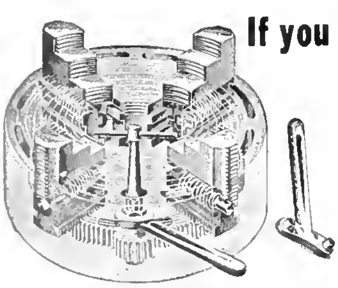
If you want the best Lathe and Drill Chucks—buy Westcott's



Spur Geared Scroll Combination Lathe Chuck.

Little Giant Auxiliary Screw Drill Chucks, Little Giant Double Grip Drill Chucks, Little Giant Improved Drill Chucks, Oneida Drill Chucks, Spur Geared Scroll Combination Lathe Chucks, Scroll Combination Lathe Chucks, Geared Combination Lathe Chucks, Geared Universal Lathe Chucks, Spur Geared Scroll Universal Lathe Chucks, IXL Independent Lathe Chucks, Cutting-off Chucks.

Strongest Grip, Greatest Capacity, Great Durability, Accurate.

WESTCOTT CHUCK CO., Oneida, N.Y., U.S.A.

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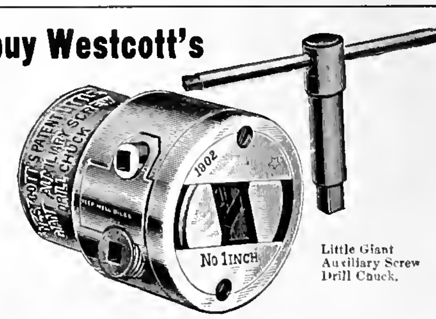

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THE OTIS

Tubular Feed Water Heater, Oil Separator and Purifier.

is not an experiment but a tried and tested appliance that the makers are not afraid to

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To heat the feed water to the *boiling point* (210 or 212 degrees) with the exhaust steam without causing any back pressure, *also to extract the oil from the exhaust*, so that the exhaust steam after being passed through the heater can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the *additional expense* of an *eliminator*.

We are so sure of the OTIS that we agree to pay all cost of a trial—freight, cartage, piping, etc., if it fails to do all we claim for it.

Catalogue and Prices at Your Service.

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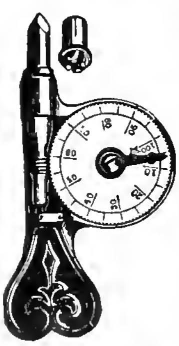

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An ingenious little instrument for ascertaining the correct speed of Dynamos, Steam Engines, Shafting, Floor Machines, etc. No first class mechanic, superintendent or factory should be without one. They are adapted to hollow or pointed centers, and are absolutely correct. Every indicator is handsomely nickel-plated and of convenient size to carry in the pocket.

Price: Split Cap, adapted to either pointed or hollow centers, $1.00.
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We also keep a Double Registering Speed Indicator. Prices on application.

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Meets every demand for convenience and effectiveness and cannot injure leather.

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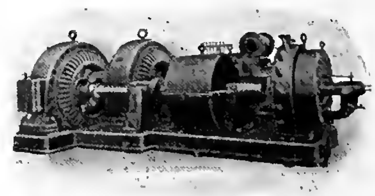

Steam Turbine Alternator, 300 H. P.

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NEW PATENT WHIP
Patent Friction Pulleys.
NONE BETTER.
MANUFACTURED BY

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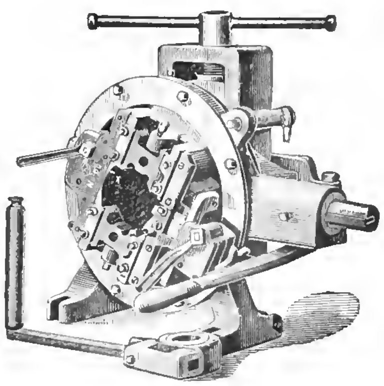

No. 00 Machine.

Armstrong's Pipe Threading and Cutting-off Machines

For Hand or Power

Save time and labor, strong and simple in construction. All the driving gears are enclosed in oil chambers, thus keeping them well lubricated and free from chips or dirt.

Capacity of different Machines.

No.	0.	Machine	¼	to	2	inches.
"	00.	"	1	"	4	"
"	1	"	1	"	3	"
"	1½.	"	1	"	4	"
"	3.	"	1	"	6	"

Catalogue sent on request.

The

Armstrong Mfg. Co.

Bridgeport, Conn.

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U.S. METAL POLISH
G. W. Hoffman, Sole Prop. 295 E. Wash. St. Indianapolis, Ind.
Trade Mark
INFALLIBLE
FOR POLISHING GOLD, SILVER PLATED WARE, NICKEL, TIN, BRASS, COPPER, Etc.
DIRECTIONS: Take a little of the Polish on a soft cloth rub the Metal hard and then wipe it off with a dry cloth
Excellent Economical No Experiment Recognized Success

Metal Polish

Highest Award

Chicago World's Fair, 1893, Louisiana Purchase Exposition St. Louis, Mo., 1904.

3-oz. Box for 10 cents. Sold by Agents and Dealers all over the world. Ask or write for FREE samples. **5-lb. Pails, $1.00.**

GEO. W. HOFFMAN
Expert Polish Maker,
Indianapolis, Indiana.

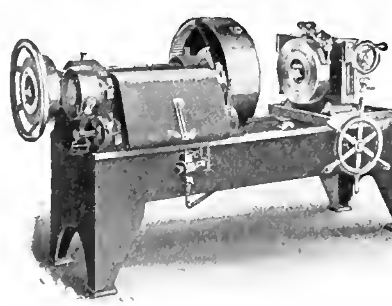
UPTON & GILMAN

Designers and Manufacturers of Mechanical Specialties.

Particularly well equipped for Die Work. General Machinists and proprietors of

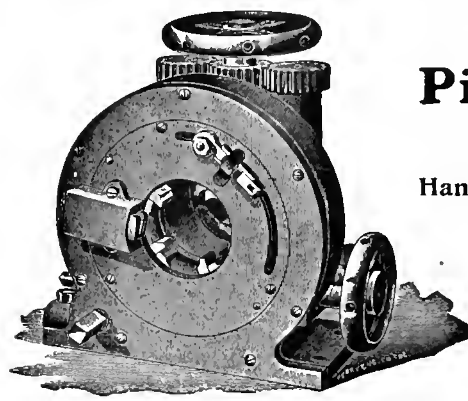
DUFF MACHINE CO.,
8 Western Ave., Lowell, Mass.

You will eventually Buy one of our Pipe Threading Machines



even though you may get one or two others first, because we have more improvements in our machines and they will do more work. Isn't that what you are looking for?

THE STOEVER FOUNDRY & MFG. CO., Myerstown, Pa.



Columbus Pipe Threading Machines.

Hand or Power. Single or Double Vise.

Columbus Gas Engines.

Columbus Machine Co.,
Columbus, Ohio.

Don't Waste Time

Forcing out pins and turning them on a lathe, use

Schoff's Portable Crank Pin Turning Machine

You'll save money
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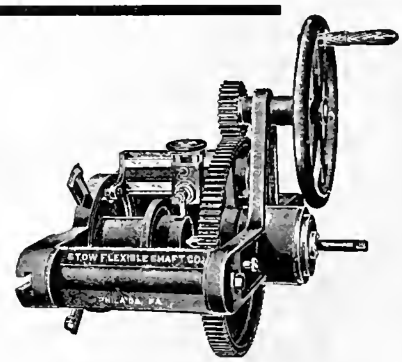
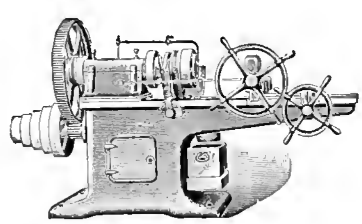




Bolt Cutters and Nut Tappers.

ALL SIZES.

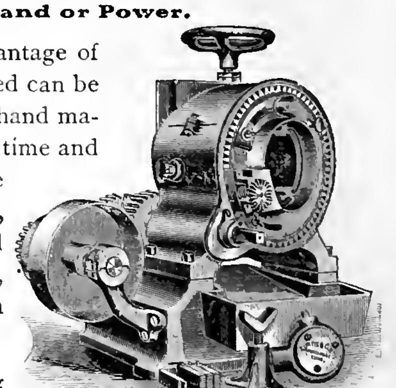
Single and Multiple Spindle, either belt or motor driven.

The Reliance Machine and Tool Company,
Cleveland, Ohio.

The Forbes Patent Die Stock

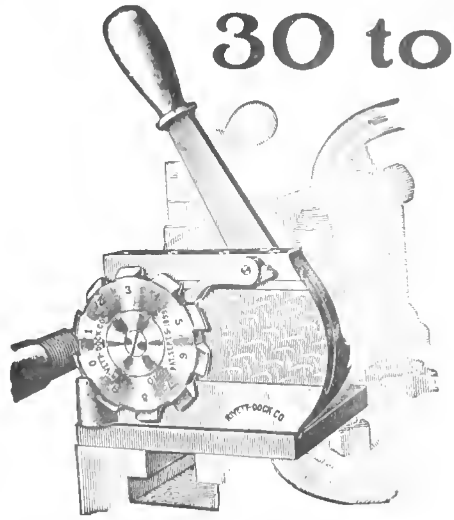
As Arranged for Hand or Power.

This machine has the double advantage of being a power machine, or when needed can be removed from the base and used as a hand machine on outside work. It has all the time and labor saving features for which the "Curtis" is noted, is complete in itself, especially valuable for work in cramped quarters, has a range from 2½" to 4", and a patent adjustment of shell by which wear is taken up.



Catalogue shows our full line of Pipe Cutting and Threading Machinery. Send for a copy.

The Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn.



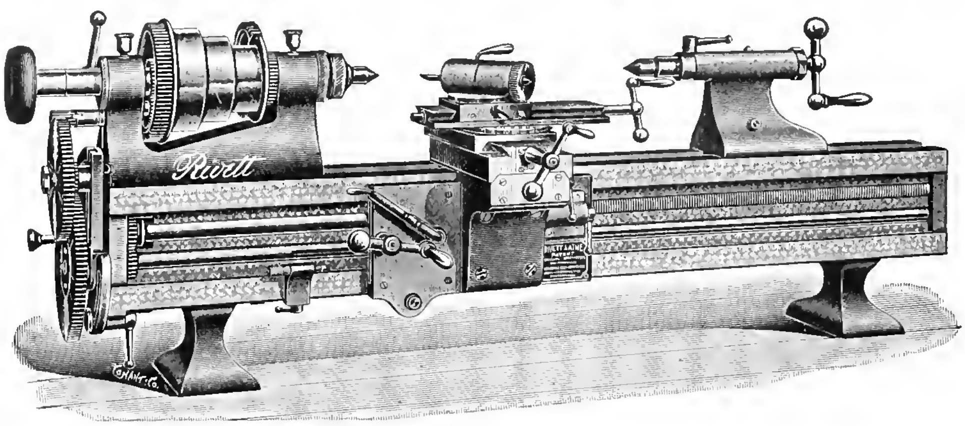
30 to 75 Per Cent *Saved*

on one class of work amounts to a very tidy little sum at the end of the year. The Rivett-Dock Threading Tool effects this saving over the old way of cutting threads with a single point tool and does better work. The Rivett-Dock Tool is simple in construction, can be operated by any workman, insures absolutely accurate threads, requires infrequent grinding and is practically indispensable for duplicate work.

Let us send you one for thirty days. A trial will convince you.

The Rivett-Dock Company, Brighton, Boston, Mass.

The "Rivett" Precision Lathe



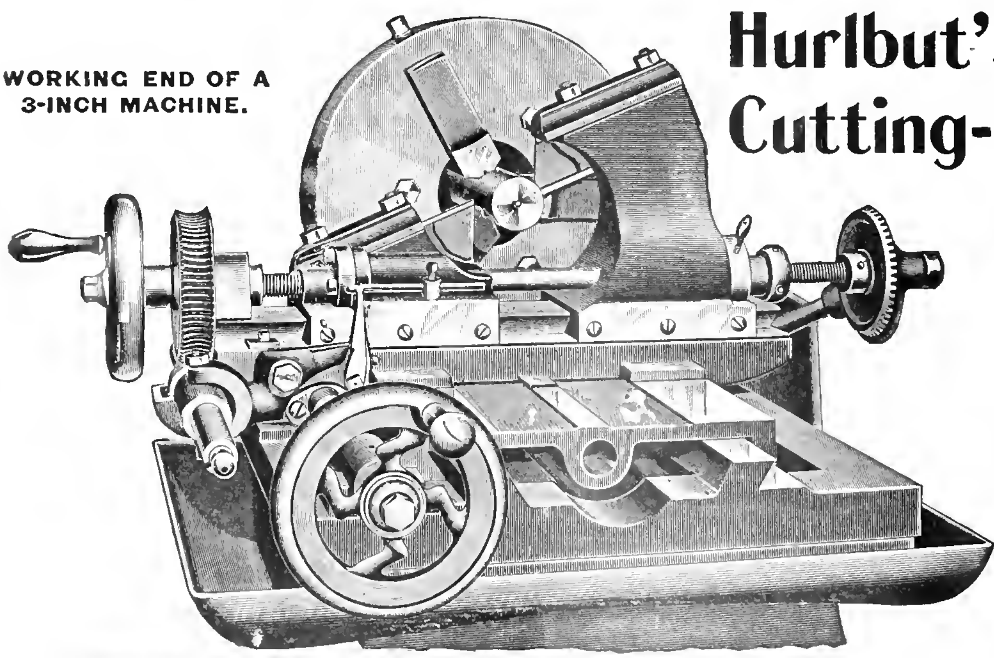
Rivett Back-Geared Precision Lathe

For those classes of work which require the extreme of accuracy, and especially valuable for tool makers, makers of fine instruments and for experimental work. This lathe, though adapted for the most delicate operations, has the strength and rigidity to stand much heavier work, and possesses advantages that put it ahead of all other precision lathes.

For furthur particulars, address

Rivett Lathes and Grinders, Brighton, Boston, Mass.

WORKING END OF A 3-INCH MACHINE.



Hurlbut's Patent Cutting-off Machine

Made in 2-inch, 3-inch, 4-inch 5-inch, 6-inch, 8-inch and 10-inch sizes.

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The largest steel and brass manufacturers use McCullough-Dalzell Crucibles. They prefer them because they have been proved by actual test. Send us an order.

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